PHEGEA

DRIEMAANDELIJKS TIJDSCHRIFT VOOR ENTOMOLOGIE

Geïndexeerd: ZR, Web of Science, BHL, EBSCO ISSN 0771-5277
Periode: april – mei – juni Erkenningsnr. P209674

Redactie: Sandra Casier (St. Niklaas), Jurgen Couckuyt (Lokeren), Guido De Prins (Merksem), Willy De Prins (Leefdaal), Alain Drumont (Brussel), Theo Garrevoet (Kontich), Alec Harmer (Lymington Hants, England, UK), Tom Sierens (Gent), Chris Steeman (Kapellen), Wim Veraghtert (Lier), Nathalie Warzée (Brussel).

Hoofdredacteur: Jurate De Prins (Canberra, Australia).
jurate.deprins@gmail.com www.phegea.org

Jaargang 51, nummer 2
1 juni 2023

Colias aurorina heldreichii, Albania, Rehovë, Ersekë, 12.vii.2019. – see page 70

Löbl I.: Editorial. Assessing Earth's biotic diversity in natural history museums – gone with the wind?..... 50

Wullaert S., Recour R. & van Nieukerken E. J.: *Ectoedemia heringella* & *Stigmella suberivora* (Lepidoptera: Nepticulidae), twee mineerders van *Quercus ilex* (Fagaceae), nieuw voor de Belgische fauna 52

Prendi M. Paparisto A. & Cuvelier S.: *Proterebia phegea* (Lepidoptera: Nymphalidae: Satyrinae): building bridges between the relic populations of Croatia, Bosnia-Herzegovina, Greece and a new record from northern Albania 59

Blicher Bjerregård E., Bjerg M., Clausen A. B., Kaj K., Glintborg S. P. & Vidҽnkjær C.: Butterflies of Albania: new surveys, four new records and a new checklist (Lepidoptera: Papilionoidea) 65

Cassar L.-F.: Is Sicily an island too far for *Papilio saharae*? Why is *Papilio machaon* rushed in where *P. saharae* is feared to tread? (Lepidoptera: Papilionidae) 77

Benyamini D.: *Melitaea telona* complex of species (Lepidoptera: Nymphalidae: Nymphalinae: Melitaeini) in the Levant and description of a new species 83

Konečný K.: A morphological study of *Leptidea* species from south-western Bulgaria.............................. 92

Boekbesprekingen 95

PHEGEA

Editorial. Assessing Earth's biotic diversity in natural history museums – gone with the wind?

Ivan Löbl

Abstract. Many members of our society ask in formal and informal meetings what is going on in natural history museums and especially in insect collections: little activity, little motivation, and little support. The editor-in-chief of *Phegea* asked an expert in museum insect collections for his opinion. Dr. Ivan Löbl is based at the natural history museum in Geneva and edited an impressive series of catalogues of Palaearctic Coleoptera https://brill.com/display/serial/CPC

Samenvatting. Veel leden van onze vereniging vragen in formele en informele vergaderingen wat er gebeurt in natuurhistorische musea en in het bijzonder in insectenverzamelingen: weinig activiteit, weinig motivatie en weinig ondersteuning. De hoofdredacteur van *Phegea* vroeg een expert in museale insectencollecties naar zijn mening. Dr. Ivan Löbl is gevestigd in het natuurhistorisch museum van Genève en bewerkt een indrukwekkende reeks catalogi van Palaearctische Coleoptera https://brill.com/display/serial/CPC.

Résumé. De nombreux membres de notre société demandent, lors de réunions formelles et informelles, ce qui se passe dans les musées d'histoire naturelle et notamment dans les collections d'insectes : peu d'activité, peu de motivation et peu de soutien. Le rédacteur en chef de *Phegea* a demandé l'avis d'un expert de collections d'insectes de musées. Le Dr. Ivan Löbl est basé au musée d'histoire naturelle de Genève et il a dirigé l'édition d'une série impressionnante de catalogues de Coleoptera paléarctiques https://brill.com/display/serial/CPC.

Key words: Collecting restrictions – Financial grant system – Insect collections — New taxa discovery.

Löbl I.: Muséum d'Histoire Naturelle, Route de Malagnou 1, 1208 Genève, Switzerland. ivan.lobl@bluewin.ch

DOI: 10.6084/m9.figshare.22722733

Introduction

The study of animals and plants was already highly appreciated by the educated classes in the 18th century. The establishment of natural history museums to preserve and display the results of expeditions was a natural outcome. At that time, being a naturalist was to build a great body of knowledge. As a consequence of the work of Carolus Linnaeus, many naturalists devoted their lives to identifying, cataloguing, and classifying species into formal groups: the taxa. Their efforts led to an assessment of nearly two million species of plants and animals. Alongside this, naturalists clarified the life history, functions in ecosystems, relationships, and evolution of many species. As a result, we have an impressive amount of knowledge at our disposal. Nevertheless, experts involved in the study of taxa are challenged by the gaps that exist and which may potentially prove to be of much importance. According to optimistic estimates, hardly a third of the extant species have been assessed and documented by vouchers in collections. Field workers interested in filling gaps in the knowledge of megadiverse organisms in poorly studied areas, such as insects in subtropical and tropical areas, are used to seeing an inexhaustible flow of unknown species in their samples. Nearly every sample of tropical forest floor litter my colleagues and I have collected yielded new, unknown species, and many of them turned out to be quite common and widespread. The ever-increasing extinction rates of populations and species have become of universal concern, as witnessed at the December 2022 Biodiversity Congress in Montreal. The extinctions affect the known and the unknown life; while the latter risks disappearing even before being documented. The fact is alarming as the knowledge of species is the foundation of the studies of the whole living environment. No doubt actions are needed. Paradoxically, while the rhetoric of politicians, heads of institutes, and media used to recognize the importance of assessing species-richness, the practice in institutions often suggests the opposite. Obviously, there is a need to highlight reasons for this trend and to suggest outcomes.

Introduced collecting restrictions

As most organisms cannot be studied in situ, sampling is a prerequisite for advancing knowledge. Nevertheless, administrations have during the last decades introduced restrictions — the same for large and slowly reproducing species as for the small and quickly reproducing ones. Thus, killing a butterfly may be criminalized just as killing a tiger. This strange equation notably affects the study of megadiverse groups. The fact that predators kill in a single day a billion times more small organisms than all those collected by humans in two centuries is ignored. Though the numbers appear astronomical, they are insignificant compared to the loss through drying wetlands, regulation of streams, planting monocultures in extensive areas, contaminating water and soil, and supporting light

pollution (to name just a few from a long list of actions responsible for extinctions). The irrational criminalization of sampling *all organisms equally* leads to the alienation of youth, who prefer laboratory work, shifting them away from a holistic view of organisms, consequently resulting in lost time, energy, and resources to those still trying to fill gaps in the field. An apogee of restrictions has been reached by the more recent Nagoya Protocol promoting fair benefit sharing, but in its application, scientific publications are not considered as a potential benefit available to all. [Comment of the editor: publications, even if they are Open Access, do not conform to all four FAIR principles: Findability, Accessibility, Interoperability, and Reusability]. Though being well-meant, many international initiatives are jointly responsible for the irreparable loss of knowledge.

Financial grant system

The financial grant system usually relies on metrics. It spread over the world in the expectation of enhancing science, whereas it induced problems due to exponentially increasing the number of proposals. The citation numbers per time unit (as the Impact Factor) are used as a measure meant for evaluating the quality of research and researchers. This agenda has perverse effects as it shifts from long-term studies of poorly known organisms to short-term studies in more popular fields. It also leads to time lost while chasing grants and responding to administrative requirements. Despite the DORA declaration (San Francisco Declaration on Research Assessment) and the opinions of leading scientists, the metrics continue to be promulgated. They are likely maintained because using an easy-to-use tool is believed to warrant a correct evaluation in any scientific field by any individual and to provide a basis for fair funding. The problem is global, though some universities and academies, such as the Swiss ones, are throwing metrics overboard.

Collections as archives of life

Museums of natural history are archives of life. Their cultural and scientific input was for generations acknowledged and they enjoyed adequate support. The fact that specimens housed in collections document the occurrence of species in space and time was recognized as important, just as the need for vouchers to verify published data, to provide the basis for unambiguous nomenclature (i.e. to ensure the correct transfer of information), to exhibit variation of features, and to document climatic changes. In addition, they have an enormous potential for providing useful information whenever new technologies are applied. Photography and samples of the genome are sometimes considered as replacements, though these are barely more than a too-small sticking plaster on a too-large wound. With scientific competition increasing, for over half a century, the idea of old-fashioned museums lacking social and scientific benefits somehow became widespread. The management of museums progressively drives to emphasize possession and protection, rather than to use the collections to improve knowledge. This shift is correlated with increasing bureaucracy and less funding. The trend is to continuously withdraw support irrespective of continually growing collections and to push scientists to address non-scientific issues. At present, many squeeze research into their own time. The reality that we know anything objectively about a species because of specimens in collections, seems to be ignored by the decision-makers. A dilemma also derives from the fact that the value of organisms in collections is correlated with the costs of sampling, conservation, and study, unlike artefacts that have their intrinsic value. The use of new technologies, such as bioinformatics and genomics, came to be appreciated in museums, though they may be applied elsewhere just as well, and they are usually disconnected from the assessment of species diversity. In addition to the attractiveness of technology, the trend is possibly stimulated by the easier achievement of metric scores.

The time span between species discovery and description

One of the effects of the present situation is the time span between the discovery of new species in the field and their formal publication. Eleven years ago, the span was found to be 21 years; in my experience, it is significantly longer for some organisms (63 years for some New Zealand alpine beetles, and nearly two centuries for the Chilean shining fungus beetle *Baeocera darwini* Löbl, 2018). Another concern is the significant amount of collected specimens remaining unstudied because of a lack of taxonomists and qualified administrators. [Comment of the editor: technical experts/administrators who could take on the administrative burden, would in this way give more time for researchers to concentrate on their research by applying modern high technological possibilities]. The issue is not only scientific: if we want a better understanding of the diversity of Earth's life, and by extension the functioning of ecosystems, we must change paradigms, regain freedom in research, and say goodbye to the metrics. Let us hope this revolution arrives before it is too late.

Ectoedemia heringella & *Stigmella suberivora* (Lepidoptera: Nepticulidae), twee mineerders van *Quercus ilex* (Fagaceae), nieuw voor de Belgische fauna

Steve Wullaert, Ruben Recour & Erik J. van Nieukerken

Samenvatting. De eerste waarnemingen van *Ectoedemia heringella* (Mariani, 1939) en *Stigmella suberivora* (Stainton, 1869) (Lepidoptera: Nepticulidae) werden vastgesteld aan de Belgische kust. Zes mijnen, waarvan enkele nog levende rupsen bevatten van *Ectoedemia heringella,* werden verzameld op 27.xii.2018 te Oostduinkerke (West-Vlaanderen). Vervolgens werden op 25.x.2020 27 verlaten mijnen en één dode rups van *Stigmella suberivora* gevonden te Knokke-Heist (West-Vlaanderen). De determinatie werd bevestigd met DNA barcodes. De biologie en verspreiding van beide soorten wordt besproken.

Abstract. *Ectoedemia heringella* (Mariani, 1939) and *Stigmella suberivora* (Stainton, 1869) (Lepidoptera: Nepticulidae) were recorded as new for Belgium from the Belgian coast. Six leafmines, some of which still contained living caterpillars of *Ectoedemia heringella* were collected on 27.xii.2018 in Oostduinkerke (West Flanders). On 25.x.2020, 27 abandoned mines and one dead larva of *Stigmella suberivora* were found in Knokke-Heist (West Flanders). The identification was confirmed by DNA barcodes. The biology and distribution of both species are discussed.

Résumé. Les premières observations de *Ectoedemia heringella* (Mariani, 1939) et de *Stigmella suberivora* (Stainton, 1869) (Lepidoptera: Nepticulidae) ont été enregistrées à la côte Belge. Six feuilles minées, dont certaines contiennent encore des chenilles vivantes d'*Ectoedemia heringella* ont été récoltées le 27.xii.2018 à Oostduinkerke (Flandre-Occidentale). Puis, le 25.x.2020, 27 feuilles minées abandonnées et une chenille morte de *Stigmella suberivora* ont été découvertes à Knokke-Heist (Flandre-Occidentale). L'identification était confirmée avec des codes-barres ADN. La biologie et la distribution des deux espèces sont discutées.

Key words: *Ectoedemia heringella* — *Stigmella suberivora* — Faunistics — First record — Belgium.

Wullaert S.: Weg naar Bijloos 15, B-3530 Houthalen, Belgium. sw.demijnen@gmail.com, www.bladmineerders.be

Recour R.: Kardinaal Cardijnlaan 6, B-8540 Deerlijk, Belgium. ruben_recour@hotmail.com

Nieukerken E. J. van: Naturalis Biodiversity Center, P.O. Box 9517, NL-2300 RA Leiden, Netherlands. nieukerken@naturalis.nl

DOI: 10.6084/m9.figshare.22722742

Inleiding

De mediterrane steeneik (*Quercus ilex*) (Fagaceae) wordt tegenwoordig vaak aangeplant aan de Belgische kust, waar deze soort door het milde klimaat min of meer winterhard is. In Zuid-Engeland was de steeneik al veel langer populair, en daar hebben zich inmiddels ook specialistische mediterrane insectensoorten op gevestigd, zoals de bladmineerders *Stigmella suberivora* (Stainton, 1869) (Waters 1928; van Nieukerken & Johansson 2003) en *Ectoedemia heringella* (Mariani, 1939) (Lepidoptera: Nepticulidae) (Langmaid & Young 2003; van Nieukerken *et al*. 2010). Het was dus te verwachten dat die soorten op termijn ook in België zouden opduiken. Tijdens verschillende excursies door leden van de Werkgroep Bladmineerders van de Vlaamse Vereniging voor Entomologie werden beide soorten nieuw voor ons land gevonden. *Ectoedemia heringella* (Mariani, 1939) werd voor het eerst opgemerkt tijdens een wandeling, niet ver van de ingang van het natuurreservaat 'Ter Yde' (Fig. 1) in Oostduinkerke op 27.xii.2018. Er werden toen voor het eerst mijnen gevonden op *Quercus ilex* (steeneik), (leg. RR, CS & RN). Deze mijnen werden bijgehouden en bewaard teneinde de determinatie achteraf te kunnen bevestigen.

Op *Quercus ilex* komt een vrij groot aantal soorten *Ectoedemia* voor. In Frankrijk betreft dit o.a. ook *Ectoedemia haraldi* (Soffner, 1942), *E. ilicis* (Mendes, 1910) en *E. algeriensis* van Nieukerken, 1985 en verder naar het oosten zijn er andere soorten (van Nieukerken *et al*. 2010).

Een aantal gedroogde rupsen werd opgestuurd naar de laatste auteur, die DNA barcodes heeft laten bepalen om de determinatie te bevestigen. De gevolgde methodes hiervoor worden besproken in van Nieukerken *et al.* (2012). Van de andere soort, *Stigmella suberivora*, die eveneens *Quercus ilex* als waardplant heeft, werden 27 verlaten mijnen gevonden en één mijn waar een dode rups inzat in Knokke-Heist (WV) op 25.x.2020 (leg. SW, KT & JV). Bij deze waarneming waren we relatief zeker van de determinatie, maar om de verwante soort *Stigmella ilicifoliella* (Mendes, 1918) uit te sluiten werd de dode rups ook opgestuurd voor een DNA-analyse. De DNA barcodes werden toegevoegd aan de Barcoding of Life Datasystems (BOLD). *Ectoedemia heringella* en *Stigmella suberivora* behoren tot de familie van de Nepticulidae Stainton, 1854 (dwergmineermotten). De Nepticulidae is een relatief grote kosmopolitische familie waarvan de meeste rupsen mijnen maken in de bladeren, sommige doen dat in de schors, bladsteel, knoppen of vruchten van de plant. Het zijn ook motjes die bij de kleinste ter wereld behoren, met een spanwijdte van 2,5 tot ongeveer 10 mm. Bijna alle soorten uit de familie Nepticulidae zijn een stuk makkelijker te vinden als bladmijn dan als imago. De imago's vertonen onderling wel verschillen, maar vaak moeten voor de determinatie genitaalpreparaten gemaakt worden. De bladmijnen daarentegen kunnen we in de meeste gevallen wel op naam brengen, al dan niet door de soort uit te kweken. In sommige gevallen is DNA onderzoek nodig wanneer de rups in de bladmijn is doodgegaan en er gelijkende soorten zijn.

Fig. 1. Het vergeefs zoeken naar mijnen op zaailingen van steeneik. Oostduinkerke, Ter Yde (WV), 25.v.2019.
© Steve Wullaert.

Waarnemingen

Tabel 1. Waarnemingen van *Ectoedemia heringella* and *Stigmella suberivora* in België. Meer details van de meeste vondsten zijn te vinden op https://waarnemingen.be/

Soort	Locatie	Specifiek	Provincie	Datum	Aantal mijnen	Aantal rupsen	Waarnemer(s)
E. heringella	Oostduinkerke	Ter Yde	WV	27.xii.2018	6	2	RR, CS, RN
	2 rupsen RMNH.INS.31337 (DNA barcode NEPTA2271-19), RMNH.INS.31338						
	Oostduinkerke	Ter Yde	WV	23.iii.2019	26	10	WB
	Oostduinkerke	Ter Yde	WV	24.iii.2019	50	10	WM
	Oostduinkerke	Ter Yde	WV	05.vii.2020	25	0	WB
	Oostduinkerke	Ter Yde	WV	07.xi.2020	86	4	RN
	Lebbeke		OV	25.iv.2021	5	2	RM
	Oostduinkerke	Ter Yde	WV	26.iv.2021	1000	5	WD
	Munte		OV	06.v.2021	1000	0	RM
	Oostduinkerke	Ter Yde	WV	30.vii.2022	150	0	WD
	Oostduinkerke	Ter Yde	WV	21.x.2022	7	0	JJ
S. suberivora	Knokke	Centrum	WV	25.x.2020	27	1	SW, KT, JV
	1 dode rups RMNH.INS.31481 (DNA barcode NEPTA2475-21)						
	Knokke	Centrum	WV	07.xi.2020	18	0	SW & ZV
	Zeebrugge	Centrum-West	WV	28.iv.2021	11	0	HDB
	Zeebrugge	Centrum-West	WV	28.iv.2021	1000	0	AB
	Knokke	Albertstrand	WV	20.vi.2021	3	0	CS
	De Panne	Centrum	WV	09.i.2022	7	0	RR
	Zeebrugge	Centrum-West	WV	02.ii.2022	1	0	SS , BDK
	Zeebrugge	Centrum-West	WV	11.ii.2022	8	2	WD
	Brugge	Sint-Jozef Brugge	WV	12.viii.2022	1♂ det. & gen. det. door Arno Beidts - BEA345M		
	Lebbeke		OV	21.viii.2022	5	0	RM

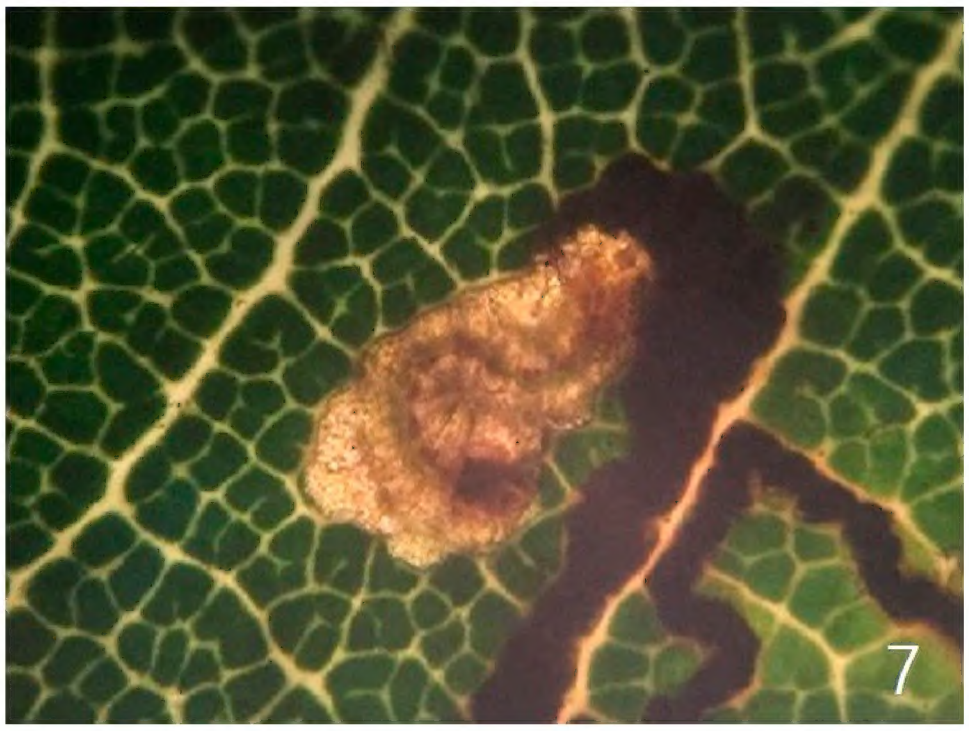


Fig. 2. *Ectoedemia heringella* op *Quercus ilex* (steeneik), Munte (OV), 06.v.2021. © Ruben Meert.

Fig. 3. *Ectoedemia heringella* op *Quercus ilex* (steeneik), Munte (OV), 06.v.2021. © Ruben Meert.

Fig. 4. *Ectoedemia heringella* op *Quercus ilex* (steeneik), Oostduinkerke, Ter Yde (WV), 27.xii.2018. Afzetting van het ei aan de bovenzijde van het blad nabij de hoofdnerf. Eischaal nog zichtbaar. © Ruben Recour.

Fig. 5. *Ectoedemia heringella* op *Quercus ilex* (steeneik), Oostduinkerke, Ter Yde (WV), 23.iii.2019. © Steve Wullaert.

Fig. 6. *Ectoedemia heringella* op *Quercus ilex* (steeneik,) Oostduinkerke, Ter Yde (WV) 26.iv.2021. Close-up van de bleke rups, let op de ventrale ganglia. © Wim Declercq.

Fig. 7. *Ectoedemia heringella* op *Quercus ilex* (steeneik), Oostduinkerke, Ter Yde (WV), 27.xii.2018. Close-up van de bleke rups, let op de ventrale ganglia. © Ruben Recour.

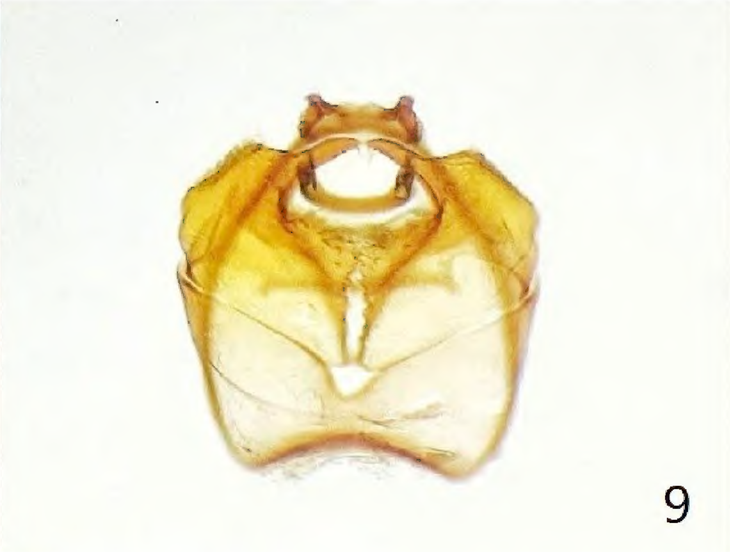


Fig. 8. *Stigmella suberivora,* Brugge, Sint-Jozef Brugge (WV), 12.viii.2022, leg. & © Johan Buckens.

Fig. 9–10. *Stigmella suberivora*, Brugge, Sint-Jozef Brugge (WV), 12.viii.2022. Det. & gen. prep. & © Arno Beidts.

Wereldwijd waren er tot 2016 in de familie van de Nepticulidae ongeveer 862 soorten gekend van 22 verschillende genera (van Nieukerken *et al*. 2016). In België komen in totaal 8 genera voor waarbij het totaal aantal Nepticulidae op 91 soorten staat (De Prins & Steeman 2023). Uit het genus *Stigmella*, dat globaal met 428 soorten het meest vertegenwoordigd is (van Nieukerken *et al*. 2016), komen in België 58 soorten voor (De Prins & Steeman 2023) en van de 89 soorten *Ectoedemia*, die wereldwijd te vinden zijn (van Nieukerken *et al*. 2016), komen er slechts 17 in België voor (De Prins & Steeman 2023). Sinds de oprichting van de Werkgroep Bladmineerders in 2005 zijn de bladminerende Lepidoptera veel beter onder de loep genomen door gedreven onderzoek binnen onze landsgrenzen. Van de 91 soorten Nepticulidae die België tot op vandaag rijk is, heeft de Werkgroep sinds de oprichting al acht soorten kunnen toevoegen; uit het genus *Stigmella* zijn dat: *Stigmella sorbi* (Stainton, 1861) (lijsterbesblaasmijnmot) (Wullaert 2012), *S. paradoxa* (Frey, 1858) (meidoornblaasmijnmot) (Wullaert 2016), *S. mespilicola* (Frey, 1856) (elsbesmineermot) (Wullaert 2017), *S. filipendulae* (Wocke, 1871) (spireamineermot) (Wullaert 2018) en *S. nivenburgensis* (Preissecker, 1942) (smalle wilgenmineermot) (Wullaert 2019). Uit het genus *Trifurcula*: *Trifurcula eurema* (Tutt, 1899) (gebandeerde rolklavermineermot) en *T. cryptella* (Stainton, 1856) (eenvlekrolklavermineermot) (Wullaert 2015) en uit het genus *Ectoedemia* is dat: *Ectoedemia minimella* (Zetterstedt, 1839) (Wullaert 2018), (gerekte berken-blaasmijnmot), en bijkomend, de twee nieuwe soorten besproken in het artikel. De biologie en de verspreiding van *E. heringella* en *S. suberivora* worden hieronder apart besproken.

Lijst met afkortingen

In dit artikel worden de afkortingen gebruikt van de Catalogue of the Lepidoptera of Belgium (De Prins 2016; De Prins & Steeman 2023). WV: West-Vlaanderen, OV: Oost-Vlaanderen. AB: Arno Beidts, BDK: Bastiaan de Ketelaere, CS: Chris Steeman, DG: Damien Gailly, HDB: Hans De Blauwe, JJ: Johannes Jansen, JV: Johan Verstraeten, KT: Koen Thonissen, RM: Ruben Meert, RN: Regis Nossent, RR: Ruben Recour, SC: Stéphane Claerebout, SS: Sebastian Stevens, SW: Steve Wullaert, WB: Werkgroep Bladmineerders, WD: Wim Declercq, WM: Wouter Mertens & ZV: Zoë Vanstraelen.

Ectoedemia heringella (Mariani, 1939) (gevlekte steeneikmineermot), nieuw voor België

Ectoedemia heringella leeft monofaag op de altijd groene eiken *Quercus alnifolia*, *Q. coccifera,* en *Q. ilex* (steeneik). In Italië werd de soort talrijk gevonden in bossen waar alleen *Quercus robur* (zomereik) voorkomt (van Nieukerken *et al*. 2010), en in Engeland is de soort bij massaal voorkomen ook op andere – niet inheemse – eiken aangetroffen: *Q, canariensis*, *Q. × crenata* en *Q. × hispanica* (Edmunds 2023). Wij hebben de soort voor het eerst aangetroffen in een voortuin op aangeplante steeneiken aan het natuurreservaat Ter Yde in Oostduinkerke. Dat de soort hoofdzakelijk leeft op groenblijvende eiken is geen toeval. De rupsen zijn te vinden in de wintermaanden vanaf oktober en blijven dooreten tot in het vroege voorjaar in april (van Nieukerken 1985, 1986) (Fig. 7). Daarna verpoppen ze. De imago's worden zelden aangetroffen, maar vliegen in juni en juli.

Het ei wordt op de bovenzijde van het blad afgezet, vaak nabij een nerf (Fig. 4). De mijn is een sterk gekronkelde gang waarbij de donkere frass de gang volledig vult (Fig. 5); de mijn neemt meestal weinig plaats in. Er zijn meestal meerdere mijnen per blad (Fig. 2, 3). De rups is witachtig en ligt met de buik naar boven in de mijn, net als de meeste Nepticulidae, behalve de meerderheid van *Stigmella*. Hierdoor zijn de karakteristieke ventrale ganglia (zenuwknopen) als bruine vlekjes zichtbaar (Fig. 6, 7). De rups verlaat de mijn aan de bovenzijde. De vlinder is te determineren met van Nieukerken *et al*. (2010).

Fig. 11 & 12. Rups van *Stigmella suberivora* op *Quercus ilex* (steeneik), Zeebrugge (WV), 11.ii.2022. © Wim Declercq.
Fig. 13. Verlaten mijn van *Stigmella suberivora* op *Quercus ilex* (steeneik), Knokke-Heist (WV), 25.x.2020. © Steve Wullaert.
Fig. 14. Zelfde mijn als Fig. 12. Mijn reeds verlaten, gefotografeerd op 13.ii.2022. © Wim Declercq.

Hij lijkt enigszins op *E. intimella* door de ene witte vlek op de voorvleugel, maar soms zijn er meer verspreide witte schubben. Het meest karakteristiek voor de mannetjes zijn de bruine androconiale schubben op de onderzijde van de voorvleugel en bovenzijde van de achtervleugel.

De soort komt in Europa van nature voor in het Middellandse Zeegebied van Zuid-Frankijk, Corsica, Sardinië en Italië tot Cyprus, maar ontbreekt op het Iberisch schiereiland. Al voor 1996 heeft de soort zich gevestigd in Zuid-Engeland waar de soort in sommige parken zeer invasief toesloeg (Langmaid & Young 2003; Nieukerken *et al*. 2010).

In sommige lanen en parken zijn de altijd groenblijvende steeneiken veranderd in, op afstand, verbruinde exemplaren (Prichard 2005). Inmiddels is *E. heringella* ook in Parijs gevonden (Jardin des Plantes, Le Kiosque, 16.xii.2014, enkele rupsen, mijnen talrijk op *Quercus ilex*, 1♂ e.l. 23.iv.2014, RMNH.INS.35483, E.J. van Nieukerken).

Sinds 2018 kunnen we ook België toevoegen aan de landenlijst van deze soort. Door het hoge aantal mijnen dat werd gevonden door de Werkgroep Bladmineerders in 2019, kunnen we misschien ook een uitbreiding verwachten door de massale aanplant van *Quercus ilex*, decoratieve en kustbeschermende plant, aan onze kustlijn en de altijd warmer wordende winters.

Stigmella suberivora (Stainton, 1869) (bruine steeneikmineermot), nieuw voor België

Tijdens de terugkeer van een excursie aan de kust op 25.x.2020 werd een bomenrij van *Quercus ilex* gecontroleerd in Knokke-Heist (WV) op aanwezigheid van *Ectoedemia heringella*, maar deze werd niet gevonden. Wel vonden we een aantal andere mijnen die in geen geval behoorden tot die soort (Fig. 13). Na controle in de literatuur kwam de naam *Stigmella suberivora* naar voren. Tussen de 27 gevonden mijnen was er één mijn met een dode rups die later werd gecontroleerd op DNA en bevestigd werd als nieuw voor de Belgische fauna (leg. SW, KT & JV). Het imago van *Stigmella suberivora* heeft een vleugelspanwijdte van 5,0 tot 7,1 mm en is daarmee een van de grotere *Stigmella* soorten. Het mannetje heeft karakteristieke lange spatelvormige androconiale schubben in de franje van de achtervleugel, ongeveer zoals bij *S. atricapitella* (Haworth, 1828) (zwartkopeikenmineermot), maar in tegenstelling tot die soort is de kop geel tot oranje (Fig. 8). Het mannelijk genitaal is erg breed, met gewelfde valven (Figs 9, 10), een kenmerk dat zonder dissectie te zien is. Het vrouwtje is niet zonder genitaalonderzoek te onderscheiden van de soorten *S. roborella* (Johansson, 1971) (gewone eikenmineermot), *S. ruficapitella* (Haworth, 1828) (variabele eiken-

mineermot) of *S. svenssoni* (Johansson, 1971) (Svenssons eikenmineermot). Voor determinatie zie van Nieukerken & Johansson (2003). De waardplanten van deze soort zijn altijd groene eiken die vooral in de Mediterrane zone voorkomen en bij ons dus alleen als aanplant te vinden zijn. *Stigmella suberivora* wordt gemeld van *Quercus ilex* (steeneik), *Q. suber* (kurkeik), *Q. coccifera* (hulsteik) en *Q. rotundifolia* (van Nieukerken & Johansson 2003). Het ei van deze soort wordt aan de bovenkant van het blad afgezet (duidelijk te zien op Fig. 13). De gele rups mineert, zoals de meeste *Stigmella's*, met de rug naar boven en maakt een brede onregelmatige gang met een brede frasslijn (Fig. 11). Alleen de randen blijven vrij van frass. Doordat de gang bijna volledig gevuld is met frass valt deze mijn goed op, hij is ook duidelijk breder dan die van *E. heringella*. De gang is meestal niet sterk gewonden en de bochten liggen niet dicht tegen elkaar, maar soms is de mijn meer gewonden, zoals in Fig. 12 en 14 (bevestigd door kweek, WD); zulke mijnen zijn lastiger van *E. heringella* te onderscheiden. Veel mijnen volgen de bladrand. De rups verlaat de mijn aan de bovenkant en laat daarbij een halvemaanvormige uitsnede achter. De rups spint een witte tot bleekbruine cocon waarin hij later verpopt (Johansson *et al*. 1990).

Stigmella suberivora heeft in Groot-Brittannië, waar deze al sinds 1928 voorkomt, twee generaties per jaar. Imago's vliegen in de maanden mei en september. Bewoonde mijnen zijn te vinden in juli en augustus en weer van november tot eind februari, of tot begin april afhankelijk van het seizoen (Emmet 1976). In de mediterrane regio zijn meerdere generaties per jaar mogelijk. Daar zijn imago's verzameld van april tot oktober (van Nieukerken & Johansson 2003). In Groot-Brittannië heeft deze soort zich sinds de ontdekking in 1928 al goed verspreid, voornamelijk langs de kustlijn. Deze soort is ook algemeen in Londen (Emmet 1976), al lijkt de soort sinds de invasie van *E. heringella* minder gewoon. Verder is ze gemeld uit Portugal en Spanje, van Zuid-Frankrijk langs de kustlijn tot in Bretagne, Italië, Corsica, Sardinië, Sicilië, Slovenië, Kroatië, Bosnië en in Noord-Afrika in Algerije en Tunesië (van Nieukerken & Johansson 2003).

Discussie

Zowel *Ectoedemia heringella* als *Stigmella suberivora* kunnen we beschouwen als ingevoerde exoten en dus niet inheems; waarschijnlijk zullen ze snel ingeburgerd raken. De kans is groot dat deze soorten zijn ingevoerd met jonge bomen uit het zuiden van Europa waar deze soorten voorkomen, of wellicht uit kwekerijen in Engeland, waar beide mineerders algemeen zijn. Kleine vlinders kunnen met sterke wind soms grote afstanden afleggen, en er zijn regelmatige scheepverbindingen waar vlinders ook mee kunnen liften. Voorlopig zijn deze soorten alleen gevonden op aanplant en nog niet op zaailingen of jonge bomen die hier zijn uitgegroeid. De toekomst zal moeten uitwijzen of deze soorten zich al dan niet kunnen uitbreiden of misschien ook op andere plaatsen zullen opduiken. De kans is alleszins reëel, want de enorme toename van de waardplant, via aanplant in tuinen en ook steeds meer als laanboom of wintergroene haag, kan ervoor zorgen dat deze beide soorten alle kansen krijgen om zich nog meer te gaan verspreiden. Het blijft opletten of andere Zuid-Europese soorten daarbij komen. Uitbreiding naar Nederland lijkt vooralsnog minder waarschijnlijk, aangezien steeneiken daar veel minder worden aangeplant.

Dankwoord

Wij zouden graag de leden van de Werkgroep Bladmineerders willen bedanken voor hun hulp en voor het verlenen van de waarnemingen: zie Tabel 1 voor alle waarnemers. Verder willen we natuurlijk de fotografen hartelijk bedanken voor het opsturen van hun foto's: Arno Beidts, Johan Buckens, Wim Declercq en Ruben Meert. Ook willen we alle personen bedanken die ervoor gezorgd hebben dat wij met onze werkgroep de natuurgebieden aan en rond de eerste vindplaats mochten inventariseren. Dan denken wij in het bijzonder aan Guy Vileyn en Evy de Wulf. Daarbij willen we natuurlijk de instantie bedanken die de vergunningen verleent: Agentschap voor Natuur en Bos. Frank Stokvis (Naturalis, Leiden) wordt bedankt voor het verrichten van de DNA analyses.

Referenties

De Prins W. 2016. Catalogus van de Belgische Lepidoptera – Catalogue of the Lepidoptera of Belgium. — *Entomobrochure* **9**: 1–247. http://www.phegea.org/Documents/CatalogueBelgianLepidoptera_2016.pdf

De Prins W. & Steeman C. 2023. *Catalogue of the Lepidoptera of Belgium*. — https://projects.biodiversity.be/lepidoptera (bezocht op 14 januari 2021).

Edmunds R. 2023. New host plants. — *LeafminesNewsletter*, **42**: 5–6. http://www.leafmines.co.uk/pdfs/newsletter%2042.pdf

Emmet A. M. 1976. Nepticulidae. — *In*: Heath J. (Ed.), *The moths and butterflies of Great Britain and Ireland Vol.I. Micropterigidae – Heliozelidae*. — Harley books, Essex, 460 pp.

Johansson R., Nielsen E. S., Nieukerken E. J. van & Gustafsson B. 1990. The Nepticulidae and Opostegidae (Lepidoptera) of North West Europe. — *Fauna entomologica scandinavica* **23** (2 vols): 1–739.

Langmaid J. R. & Young M. R. 2003. Microlepidoptera review of 2002. — *Entomologist's Record and Journal of Variation* **115**: 249–272. https://www.biodiversitylibrary.org/page/48729247

Nieukerken E. J. van 1985. A taxonomic revision of the western Palaearctic species of the subgenera *Zimmermannia* Hering and *Ectoedemia* Busck s. str. (Lepidoptera, Nepticulidae), with notes on their phylogeny. — *Tijdschrift voor Entomologie* **128**: 1–98. https://www.biodiversitylibrary.org/page/30334752

Nieukerken E. J. van 1986. Systematics and phylogeny of Holarctic genera of Nepticulidae (Lepidoptera, Heteroneura: Monotrysia). — *Zoologische Verhandelingen* **236**: 1–93.

Nieukerken E. J. van & Johansson R. 2003. The *Quercus* feeding *Stigmella* species of the West Palaearctic: new species, key and distribution (Lepidoptera: Nepticulidae). — *Tijdschrift voor Entomologie* **146** (2): 307–370.

Nieukerken E. J. van, Laštůvka A. & Laštůvka Z. 2010. Western Palaearctic *Ectoedemia* (*Zimmermannia*) Hering and *Ectoedemia* Busck s. str. (Lepidoptera: Nepticulidae): five new species and new data on distribution, hostplants and recognition. — *ZooKeys* **32**: 1–82. https://doi.org/10.3897/zookeys.32.282

Nieukerken E. J. van, Doorenweerd C., Stokvis F. R. & Groenenberg D. S. J. 2012. DNA barcoding of the leaf-mining moth subgenus *Ectoedemia* s. str. (Lepidoptera: Nepticulidae) with COI and EF1- α: two are better than one in recognising cryptic species. — *Contributions to Zoology* **81** (1): 1–24. https://doi.org/10.1163/18759866-08101001

Nieukerken E. J. van, Doorenweerd C., Hoare R. & Ray Davis D. 2016. Revised classification and catalogue of global Nepticulidae and Opostegidae (Lepidoptera, Nepticuloidea). — *ZooKeys* **628**: 65–246. https://doi.org/10.3897/zookeys.628.9799

Prichard T. 2005. *Ectoedemia heringella* (Mariani, 1939) – yet another new leaf miner for the county. — *Suffolk Moth Group Newsletter* 36. http://www.suffolkmoths.org.uk/newsletters/36/SuffolkMothGroupNewsletter36.html#heringella

Waters E. G. R. 1928. *Nepticula suberivora* Stt. in the Isle of Wight. — *Entomologist's Monthly Magazine* **64**: 1–4.

Wullaert S. 2012. *Stigmella sorbi* (Lepidoptera: Nepticulidae), new to the Belgian fauna. — *Phegea* **40**(4): 92–94. http://www.phegea.org/Phegea/2012/Phegea40-4_92-94.pdf

Wullaert S. 2015. Melding van minerende en andere zeldzame Lepidoptera in België met 10 nieuwe soorten voor de Belgische fauna (Nepticulidae, Tineidae, Gelechiidae, Momphidae, Tortricidae en Cosmopterigidae). — *Phegea* **43**(3): 50–63. http://www.phegea.org/Phegea/2015/Phegea43-3_50-63.pdf

Wullaert S. 2016. *Stigmella paradoxa* – meidoornvlekmineermot (Lepidoptera: Nepticulidae), nieuw voor de Belgische fauna. — *Phegea* **44**(2): 28–30. http://www.phegea.org/Phegea/2016/Phegea44-2_28-30.pdf

Wullaert S. 2017. Resultaten van de Werkgroep Bladmineerders uit 2016 met meldingen van minerende en andere zeldzame Lepidoptera in België en met 5 nieuwe soorten voor de Belgische fauna (Coleophoridae, Tortricidae, Gelechiidae en Nepticulidae). — *Phegea* **45**(3): 79–96. http://www.phegea.org/Phegea/2017/Phegea45-2_37-40.pdf

Wullaert S. 2018. Resultaten van de Werkgroep Bladmineerders uit 2017 met meldingen van minerende en andere zeldzame Lepidoptera in België en met 9 nieuwe soorten voor de Belgische fauna (Depressariidae, Gelechiidae, Hepialidae, Nepticulidae, Pterophoridae en Tortricidae). — *Phegea* **46**(3): 74–90. http://www.phegea.org/Phegea/2018/Phegea46-3_74-90.pdf

Wullaert S. 2019. Resultaten van de Werkgroep Bladmineerders uit 2018 met meldingen van minerende en andere zeldzame Lepidoptera in België en met tien nieuwe soorten voor de Belgische fauna (Blastobasidae, Gelechiidae, Gracillariidae, Nepticulidae en Tortricidae). — *Phegea* **47**(2): 30–46. http://www.phegea.org/Phegea/2019/Phegea47-2_30-46.pdf

Proterebia phegea (Lepidoptera: Nymphalidae: Satyrinae): building bridges between the relic populations of Croatia, Bosnia-Herzegovina, Greece, and a new record from northern Albania

Marko Prendi, Anila Paparisto & Sylvain Cuvelier

Abstract. *Proterebia phegea* (Borkhausen, 1788) (Lepidoptera: Nymphalidae: Satyrinae) is a butterfly with a restricted and fragmented distribution in the Balkan Peninsula. During a field trip on 26.iv.2022, within the area of the artificial Vau-Dejës Lake in northern Albania, the first author observed one female of *P. phegea*. The butterfly was found in a forest habitat on sandy, dark-reddish ophiolite rocky substrate. Twenty butterfly species were recorded in that area during the field trips, between March 2021 to September 2022, including *Hipparchia fagi* (Scopoli, 1763) occurring together with *Hipparchia syriaca* (Staudinger, 1871), *Hipparchia statilinus* (Hufnagel, 1766), and ten species of Odonata. This is only the second locality in Albania where *P. phegea* has been found. These two distant localities form a bridge between the well-documented populations of Croatia, Bosnia-Herzegovina, and Greece. The dragonfly, *Trithemis annulata* (Palisot de Beauvois, 1807) is new for northern Albania. The known and potential distribution, phenology and conservation status of *P. phegea* in Albania are discussed.

Samenvatting. *Proterebia phegea* (Borkhausen, 1788) (Lepidoptera: Nymphalidae: Satyrinae) is een dagvlinder met een beperkte en gefragmenteerde verspreiding op het Balkan schiereiland. Tijdens veldwerk op 26.iv.2022 vond de eerste auteur één wijfje *P. phegea* in de omgeving van het Vau-Dejës stuwmeer. De vlinder werd gevonden in een bosbiotoop met een zanderige, donkerrode ofioliet rotsondergrond. Tijdens veldwerk van maart 2021 tot september 2022 werden er twintig soorten dagvlinders gevonden waaronder *Hipparchia fagi* (Scopoli, 1763) die er samen voorkomt met *Hipparchia syriaca* (Staudinger, 1871) en *Hipparchia statilinus* (Hufnagel, 1766) alsook tien soorten Odonata. Dit is pas de tweede plaats in Albanië waar *P. phegea* werd gevonden. Deze twee verafgelegen plaatsen vormen een brug tussen de goed gedocumenteerde populaties van Kroatië, Bosnië-Herzegovina en Griekenland. De libel, *Trithemis annulata* (Palisot de Beauvois, 1807) is nieuw voor het Noorden van Albanië. De gekende en potentiële verspreiding, fenologie en status van *P. phegea* in Albanië worden besproken.

Përmbledhje. *Proterebia phegea* (Borkhausen, 1788) (Lepidoptera: Nymphalidae: Satyrinae) është një flutur me një shpërndarje të kufizuar dhe të fragmentuar. Gjatë një udhëtimi në terren më 26.iv.2022, në zonën e liqenit artificial të Vau-Dejës në veri të Shqipërisë, autori i parë vëzhgoi në terren dhe koleksionoi një femër *P. phegea*. Flutura u gjet në një habitat pyjor në një substrat shkëmbor me rërë të kuqërremtë të errët ofioliti. Njëzet lloje fluturash u regjistruan në atë zonë gjatë udhëtimeve në terren, nga marsi 2021 deri në shtator 2022, duke përfshirë *Hipparchia fagi* (Scopoli, 1763) që është bashkëgjetur me *Hipparchia syriaca* (Staudinger, 1871) dhe *Hipparchia statilinus* (Hufnagel 1766) dhe dhjetë lloje Odonata. Ky është lokaliteti i dytë në Shqipëri ku është gjetur *P. phegea*. Këto dy lokalitete të largëta formojnë një urë lidhëse midis popullatave të mirë dokumentuara të Kroacisë, Bosnje-Hercegovinës dhe Greqisë. Piliveza, *Trithemis annulata* (Palisot de Beauvois, 1807) është një lloj tjetër i ri për Shqipërinë e Veriut. Në këtë artikull diskutohet shpërndarja e njohur dhe e mundshme, fenologjia dhe statusi i ruajtjes së *P. phegea* në Shqipëri.

Résumé. *Proterebia phegea* (Borkhausen, 1788) (Lepidoptera : Nymphalidae : Satyrinae) est un papillon dont la distribution est restreinte et fragmentée dans la péninsule balkanique. Lors d'une sortie sur le terrain le 26.iv.2022, dans la zone du lac artificiel Vau-Dejës dans le nord de l'Albanie, le premier auteur y a observé une femelle de *P. phegea*. Le papillon a été trouvé dans un habitat forestier sur un substrat rocheux sableux d'ophiolite rouge foncé. Vingt espèces de papillons ont été enregistrées dans cette zone lors des sorties sur le terrain, entre mars 2021 et septembre 2022, y compris *Hipparchia fagi* (Scopoli, 1763) se trouvant avec *Hipparchia syriaca* (Staudinger, 1871), *Hipparchia statilinus* (Hufnagel, 1766) et dix espèces d'Odonata. Ce n'est que la deuxième localité en Albanie où *P. phegea* a été trouvé. Ces deux localités éloignées forment un pont entre les populations bien documentées de Croatie, de Bosnie-Herzégovine et de la Grèce. L'espèce de libellule, *Trithemis annulata* (Palisot de Beauvois, 1807) est nouvelle pour le nord de l'Albanie. La distribution connue et potentielle, la phénologie et le statut de conservation de *P. phegea* en Albanie sont discutés.

Key words: *Proterebia phegea* — Lepidoptera — Papilionoidea — *Trithemis annulata* — Odonata — Albania — Shkodër — Vau-Dejës — Faunistics — Habitat — Conservation.

Prendi M.: Faculty of Natural Sciences, Department of Biology, Bulevardi Zogu i Parë, Tirana University, Al-1001 Tirana, Albania. markoprendi16051999@gmail.com

Paparisto A.: Faculty of Natural Sciences, Department of Biology, Bulevardi Zogu i Parë, Tirana University, Al-1001 Tirana, Albania. anila.paparisto@yahoo.com

Cuvelier S.: Diamantstraat 4, B-8900 Ieper, Belgium. sylvain.cuvelier@telenet.be

DOI: 10.6084/m9.figshare.22722754

Introduction

Albania is located on the western edge of the Balkan Peninsula, with a mostly mountainous relief. The region of the Vau-Dejës Lake has a Mediterranean climate with 14.7°C average annual temperature and an average precipitation of 1528 mm per year. The study area is characterized by a variety of ecosystems, including aquatic ecosystems, Mediterranean evergreen and deciduous shrubs, coniferous and mixed broad-leaved forests, meadows and pastures. Typical for the area are: *Pinus pinea* L., *P. halepensis* Mill., *P. nigra* J.F.Arnold, *Quercus cerris* L., *Q. ilex* L., *Carpinus betulus* L., *Fraxinus angustifolia* Vahl, *Satureja montana* L., *Achillea mille-*

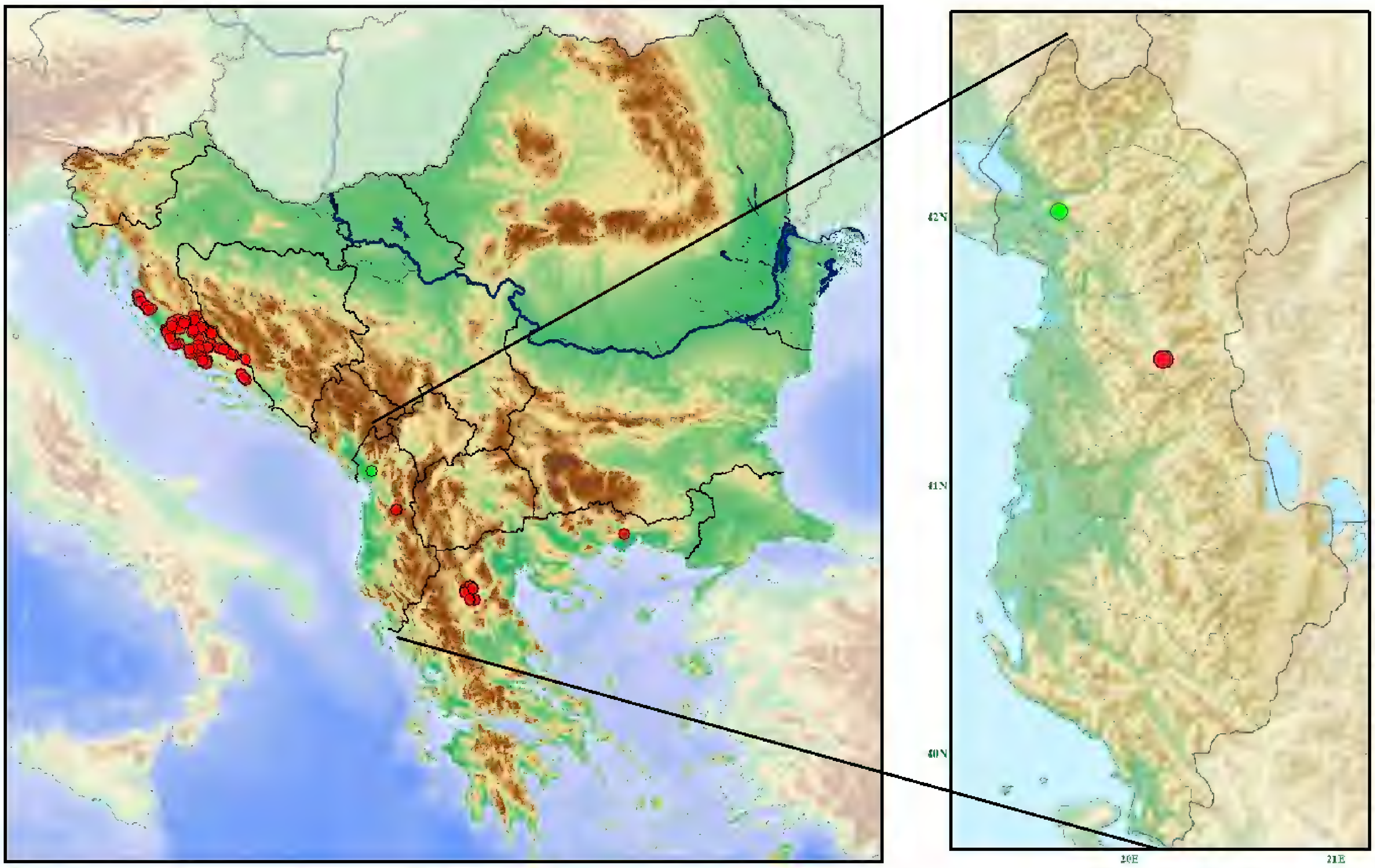


Fig. 1. Left: distribution of *Proterebia phegea* in the Balkan Peninsula. Right: distribution of *Proterebia phegea* in Albania. Records including coordinates from three sources: literature, own surveys and those kindly provided by other entomologists. New record of *P. phegea* (this paper).

folium L., *Juniperus oxycedrus* L. etc. (Vau-Dejës 2017). The first comprehensive overview of the butterfly fauna for Albania was compiled by Rebel & Zerny (1931), and during the long period of isolation only a few publications focused on Albania. The publication by Misja (2005) represented the first time that distribution maps for all known species were available. The most recent checklist (Cuvelier *et al*. 2018) presents 196 confirmed butterfly species. *Proterebia phegea* (Borkhausen, 1788) was never listed or mentioned as a potential target for research in Albania. In July 2022, Verovnik & Verovnik provided the first information concerning the unexpected discovery on 27.iv.2022: *P. phegea* was flying in good numbers on south-facing slopes near Bulqizë (Dibër County).

Proterebia phegea is a species whose adults tolerate harsh continental conditions (Bartoňová 2017), is single brooded and flies in early spring. It has been found from sea level up to almost 1500 m a.s.l. Until recently, *P. phegea* was only documented in the Balkans from disjunct, relict populations in Croatia, Bosnia-Herzegovina, and Greece (Fig. 1). In recent years, Albania has received more attention from butterfly researchers, but the area of Vau-Dejës in North Albania remained unexplored. Comprehensive data on the distribution and conservation status of *P. phegea* in Albania is still poor as the species has only recently been documented. The goal of this article is to improve the knowledge on the potential distribution of *P. phegea* in Albania, to tentatively assess its conservation status, and to document the diversity of the Vau-Dejës region. The most remarkable data from the surveys for the Papilionoidea and Odonata are briefly analysed and summarised as supplementary material.

Material and methods

Six sites (S1) with varied biotopes were selected within the Vau-Dejës region. Collecting was done using the insect net. Captured specimens were killed and placed in paper envelopes, marked with the date and coordinates. For preparation for the entomological reference collection, individuals were softened with water vapour in plastic boxes for 24 hours and then set on polystyrene using entomological pins. Each individual was labelled with the scientific name, date of collection and coordinates according to Misja (2005) and Paparisto *et al.* (2005). Identification was based on external (Tolman & Lewington 1997; Dijkstra & Lewington 2006) and genital characters (Beshkov 1995). The identifications of *Hipparchia fagi* (Scopoli, 1763) and *Hipparchia syriaca* (Staudinger, 1871) are based on genitalia dissections, as these two species are externally indistinguishable. Observational data of *P. phegea*, with precise coordinates, were compiled from the literature and from information kindly provided by other researchers. The distribution maps were created with DMAP, distribution mapping software.

Results and discussion

During the weekly field surveys (March 2021–September 2022) for the master thesis of the first author, 20 species of butterflies and 10 species of Odonata (S1) were recorded in the six selected sites (S1) of the Vau-Dejës region. In site 5, 100 m a.s.l., the first author

Fig. 2. Female of *Proterebia phegea*, Vau-Dejës, 26.iv.2022 (Coll. and © M. Prendi); a, upperside, b, underside.

sampled a female *P. phegea* (Fig. 2) on 26.iv.2022 near the road (42.0197N 19.6625E) in a forest habitat (Fig. 3a) on sandy, dark-reddish, ophiolite rocky substrate (Fig. 3b) with *Juniperus* spp., *Pinus* spp. and typical undergrowth of *Festuca* spp. The locality is 144 km NE of the first published records (Verovnik *et al.* 2022) from the Bulqizë area, +/- 750 m a.s.l., and represents an important extension for the Albanian range of *P. phegea* (Fig. 1). Most of the known localities in Croatia, the adjacent locality in Bosnia-Herzegovina and Greece are open, well-exposed habitats on grey-whitish limestone. Typical habitats are found on dry, rocky karstic meadows with sparse vegetation. In the Dalmatian part of its range *P. phegea* also occurs in more overgrown sites with similar vegetation.

This observation confirms the occurrence of *P. phegea* in localities with a similar habitat, structure and vegetation on ophiolite substrate. Two of the three localities known to us are located within the large ophiolite zone of Albania and belong to two different tectonic zones. The habitat near Bulqizë is located in the Inner Albanides and the area around Vau-Dejës Lake is situated in the Outer Albanides. Both these areas have a rather similar lithological composition. In Greece, *P. phegea* is also present on ophiolites in scattered localities on the south-western slopes of Mt. Vourinos (personal observation third author).

P. phegea has a rather continuous range in the Pontic steppes and northern parts of the Irano-Turanian biogeographic region. The phylogeography of *P. phegea* (Bartoňová *et al.* 2018) shows that the Balkan populations are distinct but were repeatedly connected in between the glacial cycles to the rest of the range. The Dalmatian lineage is closely related to Turkish haplotypes; the Greek haplotypes are closely related to butterflies north of the Greater Caucasus.

In Europe, *P. phegea* has disjunct populations. It was first discovered in Croatia and is known from 60 sites in total, including the island of Pag in the northwest, to the Biokovo Mts. in the south (Koren *et al*. 2010; Bartoňová 2019). In 1984, *P. phegea* was discovered in Greece by the late Simos Ichtiaroglou (De Louker & Dils 1987) and is recorded in western Greek Macedonia on Mt. Siniátsiko, on the hills just north of the town of Siatista, and on Mt. Vourinous near Kozani (Pamperis, oral communication). More recently *P. phegea* has also been recorded by Lazaros Pamperis in the Rhodopi Mts. in north-eastern Greece (Pamperis 2011). *P. phegea* is very local in Greece though quite common where found. On April 2011 *P. phegea* was also confirmed from Bosnia-Herzegovina, near the Croatian border, only a marginal extension inland of its range in Dalmatia (Koren & Trkov 2011). The recent Albanian discoveries near Bulqizë and at the Vau-Dejës Lake form a bridge between the well-documented populations found in Croatia, Bosnia-Herzegovina, and Greece. The butterfly is not only present in open and exposed localities on grey-whitish limestone substrate but also in more overgrown sites on limestone and ophiolite substrates.

Fig. 3. Vau-Dejës, 26.iv.2022, a, Forest habitat b, ophiolite substrate. © M. Prendi.

The altitude of the two Albanian localities is in line with the European range: from sea level up to almost 1500 m a.s.l. (Koren *et al*. 2010; Bartoňová 2017). *P. phegea* is a species of the early spring: adults have been observed from the beginning of March till the end of May (Koren *et al*. 2010). The single female, not perfectly fresh, observed at +/-100 m a.s.l. in the Vau-Dejës area is a potential indication that the species was at the end of its flight time on 26.iv.2022 in this lowland locality. In Bulqizë, the majority of the specimens were mostly fresh males and newly emerged females on 27.iv.2022, indicating that this was more or less in the middle of the flight time at 750 m a.s.l. (Verovnik & Verovnik 2022).

According to the Red List Status of the European butterflies (van Swaay *et al.* 2010) and the Red List of Mediterranean butterflies (Numa *et al.* 2016) based on the IUCN categories and criteria, *P. phegea* is classified in the category LC (Least Concern). For Albania the Red List category is NE (not evaluated).

For the moment the threats in the two localities are low but not non-existent. Road works, building and quarrying along the SH6 road near Bulqizë could have a dramatic effect on the current known localities of *P. phegea*. The Vau-Dejës population probably has declined due to the damming. Deforestation and urbanization may pose additional threats in the future.

Fig. 4. *Trithemis annulata*, Vau-Dejës, 05.iv.2021. © M. Prendi.

Intermediate grazing pressure (Bartoňová 2019), suppressing shrubs and trees and keeping enough dry grass litter, is present in Croatian and Greek habitats where thriving populations of *P. phegea* are present. Increased grazing is a serious threat. In the same locality, during the summer months, *H. fagi*, *H. syriaca* and *Hipparchia statilinus* (Hufnagel, 1766) are syntopic, further underlying the natural value of the area of the Vau-Dejës region. Vau-Dejës is speaking through its biodiversity. Ten species of Odonata were recorded in the Vau-Dejës region belonging to eight genera and four families (S1). *Trithemis annulata* (Palisot de Beauvois, 1807) (Fig. 4) is recorded for the first time for North Albania and this dragonfly species was only recorded for the first time in South Albania (Shkëmbi 2019) in 2018.

Conclusion

Further efforts are needed to estimate the status of the *P. phegea* population in the Vau-Dejës Lake region where more open habitats also have potential for the species, and to survey other localities with suitable ophiolite habitat from north-eastern Albania, near the Republic of Kosovo, to the county of Korçë in south-eastern Albania, near Greece. Other surveys that might bring new evidence can focus on the karst habitats between Dalmatia to North Albania and the ophiolite zones in the Republic of Northern Macedonia.

Also, future molecular research is needed to elucidate the biogeography of these recently found Albanian populations of *P. phegea*. The Vau-Dejës region is home to important butterfly and dragonfly species. Further research is expected to document its full potential, as is the case in many more localities in North Albania.

Acknowledgements

We thank Hristos Anastassiu, John Coutsis, Toni Koren, Lazaros Pamperis, and Roger Vila for information about *P. phegea* in their country and/or for providing coordinates of observations. We are grateful for the support of the University of Tirana's project for the endangered species of Albania, financed by the Albanian Research and Innovation Agency with contract No. 256 Prot., dated 16.09.2019 managed by Prof. Lulëzim Shuka. We also thank Dr. Arben Belba, Tirana University, Faculty of History and Philology, for his personal communication on tectonic and lithological maps of Albania.

Supplementary material. Study sites and results of the field surveys for Papilionoidea and Odonata in the Vau-Dejës region

Fig. S1. Map of the study sites (source: Google Earth and adapted by Marko Prendi)

Table S1. Study sites.

Site number	Site name	Latitude	Longitude	Altitude (m)
1	Mjedë	42.0023	19.6353	21
2	Zadejë	42.0058	19.3742	40
3	Rragam	42.0145	19.3745	100
4	Qersaq	42.0106	19.3839	90
5	Vau-Dejës	42.0114	19.3938	75
6	Gomsiqe	42.0123	19.4053	75

Table S2. Study results.

Lepidoptera Papilionoidea	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6
Iphiclides podalirius	*	*	*	*	*	*
Papilio machaon	*	*	*	*	*	*
Colias crocea	*					
Gonepteryx rhamni	*					
Pieris brassicae	*	*			*	*
Pieris rapae	*					
Pontia edusa	*					
Lycaena phlaeas					*	*
Polyommatus icarus	*	*	*	*	*	*
Argynnis paphia					*	
Melitaea cinxia					*	
Melitaea trivia					*	
Polygonia egea	*					
Vanessa atalanta	*	*			*	
Vanessa cardui	*	*			*	
Coenonympha pamphilus	*	*	*	*	*	*
Hipparchia fagi					*	
Hipparchia statilinus					*	
Hipparchia syriaca					*	
Proterebia phegea					*	
Odonata						
Ischnura elegans	*					

Enallagma cyathigerum	*	*			*	*
Anax imperator					*	
Lindenia tetraphylla	*					
Orthetrum brunneum		*				
Orthetrum cancellatum	*	*	*	*	*	*
Orthetrum coerulescens		*				
Sympetrum fonscolombii					*	*
Crocothemis erythraea	*	*			*	
Trithemis annulata	*				*	

References

Bartoňová A., Kolář V., Marešová J., Sasic M., Slancarova J., Suchacek P., Konvicka M. 2017. Isolated Asian steppe element in the Balkans: habitats of *Proterebia afra* (Lepidoptera: Nymphalidae: Satyrinae) and associated butterfly communities. — *Journal of Insect Conservation* **21**: 559–571. https://link.springer.com/article/10.1007/s10841-017-9995-x

Bartoňová A., Konvicka M., Korb S., Kramp K., Schmitt T. & Fric Z. 2018. Range dynamics of Palearctic steppe species under glacial cycles: the phylogeography of *Proterebia afra* (Lepidoptera: Nymphalidae: Satyrinae). — *Biological Journal of the Linnean Society* **125**(4): 867–884. https://academic.oup.com/biolinnean/article/125/4/867/5124555.

Bartoňová, A. 2019. *Butterfly diversity of the species-rich Submediterranean region*. — Ph.D. Thesis Series, No. 10. University of South Bohemia, Faculty of Science, School of Doctoral Studies in Biological Sciences, České Budějovice, 165 pp. https://theses.cz/id/md70w8/PhDthesis_Bartonova_2019.pdf

Beshkov S. 1995. Contribution to the knowledge of the Lepidoptera fauna of Albania 2. Some findings of a collecting trip in September 1993 (Lepidoptera, Macrolepidoptera). — *Atalanta* **26**(1/2): 365–399.

Cuvelier S., Parmentier L., Paparisto A. & Couckuyt J. 2018. Butterflies of Albania – Fluturat e Shqipërisë. New surveys, new species and a new checklist (Lepidoptera: Papilionoidea). — *Phegea* **46**(2): 48–69. http://www.phegea.org/Phegea/2018/Phegea46-2_48-69.pdf

De Louker S. & Dils J. 1987. The occurrence of *Proterebia phegea* Borkhausen in Greece with description of a new subspecies (Lepidoptera: Nymphalidae: Satyrinae). — *Phegea* **15**(3): 157–160. http://www.phegea.org/Phegea/1987/Phegea15-3_157-160.pdf

Dijkstra K. & Lewington R. 2006. *Field Guide to the Dragonflies of Britain and Europe*. — British Wildlife Publishing, 320 pp.

DMAP, distribution mapping software http://www.dmap.co.uk/ — Dr. Alan Morton, Blackthorn Cottage, Chawridge Lane, Winkfield, Windsor, Berkshire, SL4 4QR, UK.

Koren T., Burić I., Štih A., Zakšek V. & Verovnik R. 2010. New data about the distribution and altitudinal span of Dalmatian Ringlet, *Proterebia afra dalmata* (GODART, [1824]) (Lepidoptera: Satyrinae) in Croatia. — *Acta Entomologica Slovenica* **18**(2): 143–150. http://www2.pms-lj.si/pdf/Acta/AES_18-2_5_KOREN.pdf

Koren T. & Trkov D. 2011. *Proterebia afra dalmata* (Godart, 1824) (Lepidoptera, Satyrinae) recorded for the first time in Bosnia and Herzegovina. — *Natura sloveniae* **13**(2): 57–58. http://web.bf.uni-lj.si/bi/NATURA-SLOVENIAE/pdf/NatSlo_13_2_7.pdf

Misja K. 2005. *Fluturat e Shqipërisë. Macrolepidoptera (Rhopalocera, Bombyces & Sphinges, Noctuidae, Geometridae)*. — Akademia e Shkencave e Shqipërisë, Instituti i Kërkimeve Biologjike,Tiranë, 247 pp. https://www.researchgate.net/publication/364348057_Misja_2005_FLUTURAT_E_SHQIPERISE

Numa C. van Swaay C., Wynhoff I., Wiemers M., Barrios V., Allen D., Sayer C., López Munguira M., Balletto E., Benyamini D., Beshkov S., Bonelli S., Caruana R., Dapporto L., Franeta F., Garcia-Pereira P., Karaçetin E., Katbeh-Bader A., Maes D., Micevski N., Miller R., Monteiro E., Moulai R., Nieto A., Pamperis L., Pe'er G., Power A., Šašic M., Thompson K., Tzirkalli E., Verovnik R., Warren M. & Welch H. 2016. *The status and distribution of Mediterranean butterflies*. — IUCN, Malaga, Spain. 32 pp. https://portals.iucn.org/library/sites/library/files/documents/RL-2016-001.pdf

Pamperis L. 2009. *The butterflies of Greece. Second Edition revised and enlarged*. — Editions Pamperis, Athens, 766 pp.

Pamperis L. 2011. The presence of *Proterebia afra* (Fabricius, 1787) (Lepidoptera: Satyridae) in the Rhodópe Mts, NE. Greece. — *Entomologist's Gazette* **62**: 236.

Paparisto A. & Misja K. 2005. *Manual i laboratorëve të entomologjisë*. — JULVIN 2. Tiranë, 136 pp.

Rebel H. & Zerny H. 1931. Die Lepidopterenfauna Albaniens. — *Denkschriften der Akademie der Wissenschaften Wien, mathematischnaturwissenschaftliche Klasse* **103**: 37–161. https://www.zobodat.at/pdf/DAKW_103_0037-0161.pdf

Shkëmbi E. 2019. *Të dhëna sistematike dhe ekologjike për Rendin Odonata në Shqipëri. Punime Doktorate. Fakulteti i Shkencave të Natyrës, Universiteti i Tiranës* 274 pp. — https://api.fshn.edu.al/uploads/Enilda_Shkembi_Doktorature_Biologji_8fa1e10dce.pdf

Tolman T. & Lewington R. 1997. *Field Guide of the Butterflies of Britain and Europe*. — Harper Collins Publishers, London, 320 pp.

van Swaay C., Cuttelod A., Collins S., Maes D., López Munguira M., Šašić M., Settele J., Verovnik R., Verstrael T., Warren M., Wiemers M. & Wynhof I. 2010. *European red list of butterflies.* — Publications Office of the European Union, Luxembourg, 60 pp. https://data.europa.eu/doi/10.2779/83897

Vau-Dejës 2017. *Analiza e thelluar dhe vlerësimi i gjendjes aktuale të territorit*. — Bashkia, Vau-Dejës 218 pp. http://www.vaudejes.gov.al/wp-content/uploads/2017/03/ANALIZA-E-THELLUAR-DHE-VLER%C3%AFSIMI-I-GJENDJES-EKZISTUESE-T%C3%AF-TERRITORIT.pdf

Verovnik R. & Popović M. 2013. Annotated checklist of Albanian butterflies (Lepidoptera, Papilionoidea and Hesperioidea). — *Zookeys* **323**: 75–89. https://zookeys.pensoft.net/articles.php?id=3527

Verovnik R. & Verovnik J. 2022. First record of *Proterebia phegea* (Lepidoptera: Satyrinae) from Albania. — *Natura Croatica* **31**(1): 115–120. https://hrcak.srce.hr/file/407277

Butterflies of Albania: new surveys, four new records and a new checklist (Lepidoptera: Papilionoidea)

Emil Blicher Bjerregård, Martin Bjerg, Allan Bornø Clausen, Kaj Dahl, Søren Peter Glintborg & Christian Videnkjær

Abstract. The butterfly fauna of Albania is probably the least studied in Europe. Albania has been completely isolated for decades and is known as an extremely difficult country for studying insects. In the summer of 2019 Dansk Lepidopterologisk Forening arranged the expedition called CASMEK1 to Albania to provide information about the butterfly fauna. In 2017 two expeditions were carried out by VVE1 and VVE2, which were two teams with focus on studying the butterfly fauna of Albania. Among other observations, VVE1 and VVE2 found four new species for Albania. Also, for this survey, four further new species for Albania were recorded: *Limenitis camilla* (Linnaeus, 1764), *Araschnia levana* (Linnaeus, 1758), *Euphydryas maturna* (Linnaeus, 1758), and *Erebia alberganus* (Prunner, 1798) (Nymphalidae). In addition to the new species for Albania, other interesting records are also reviewed in this article. Information is provided on *Spialia phlomidis* (Herrich-Schäffer, 1845) (Hesperiidae), *Colias aurorina* Herrich-Schäffer, 1850 (Pieridae), *Apatura iris* (Linnaeus, 1758), *Boloria titania* (Esper, 1793), *Melitaea diamina* (Lang, 1789), *Pseudochazara amymone* Brown, 1976, and *Pseudochazara tisiphone* Brown, 1981 (Nymphalidae). All three teams (CASMEK1, VVE1, and VVE2) contributed to the distribution records of the butterfly fauna of Albania.

Samenvatting. De vlinderfauna van Albanië is waarschijnlijk de minst bestudeerde van Europa. Albanië is decennialang volledig geïsoleerd geweest en staat bekend als een uiterst moeilijk land voor het bestuderen van insecten. In de zomer van 2019 organiseerde Dansk Lepidopterologisk Forening de expeditie CASMEK1 naar Albanië om informatie te verstrekken over de vlinderfauna. In 2017 werden twee expedities uitgevoerd door VVE1 en VVE2, twee teams die zich richtten op het bestuderen van de vlinderfauna van Albanië. Naast andere waarnemingen vonden VVE1 en VVE2 vier nieuwe soorten voor Albanië. Bij dit onderzoek werden nog eens vier nieuwe soorten voor Albanië genoteerd: *Limenitis camilla* (Linnaeus, 1764), *Araschnia levana* (Linnaeus, 1758), *Euphydryas maturna* (Linnaeus, 1758) en *Erebia alberganus* (Prunner, 1798) (Nymphalidae). Naast de nieuwe soorten voor Albanië worden in dit artikel ook andere interessante records besproken. Er wordt informatie verstrekt over *Spialia phlomidis* (Herrich-Schäffer, 1845) (Hesperiidae), *Colias aurorina* Herrich-Schäffer, 1850 (Pieridae), *Apatura iris* (Linnaeus, 1758), *Boloria titania* (Esper, 1793), *Melitaea diamina* (Lang, 1789), *Pseudochazara amymone* Brown, 1976 en *Pseudochazara tisiphone* Brown, 1981 (Nymphalidae). De drie teams (CASMEK1, VVE1 en VVE2) hebben alle bijgedragen aan de verspreidingsgegevens van de vlinderfauna van Albanië.

Résumé. La faune de papillons de l'Albanie est probablement la moins étudiée d'Europe. L'Albanie a été complètement isolée pendant des décennies et est connue comme un pays extrêmement difficile pour l'étude des insectes. Au cours de l'été 2019, la Dansk Lepidopterologisk Forening a organisé l'expédition appelée CASMEK1 en Albanie pour fournir des informations sur la faune des papillons. En 2017, deux expéditions ont été menées par VVE1 et VVE2, qui étaient deux équipes dont l'objectif était d'étudier la faune des papillons de l'Albanie. Entre autres observations, VVE1 et VVE2 ont découvert quatre nouvelles espèces pour l'Albanie. En outre, pour cette enquête, quatre autres nouvelles espèces pour l'Albanie ont été enregistrées : *Limenitis camilla* (Linnaeus, 1764), *Araschnia levana* (Linnaeus, 1758), *Euphydryas maturna* (Linnaeus, 1758) et *Erebia alberganus* (Prunner, 1798) (Nymphalidae). En plus des nouvelles espèces pour l'Albanie, d'autres signalements intéressants sont également passés en revue dans cet article. Des informations sont fournies sur *Spialia phlomidis* (Herrich-Schäffer, 1845) (Hesperiidae), *Leptidea juvernica* Williams, 1946, *Colias aurorina* Herrich-Schäffer, 1850 (Pieridae), *Apatura iris* (Linnaeus, 1758), *Boloria titania* (Esper, 1793), *Melitaea diamina* (Lang, 1789), *Pseudochazara amymone* Brown, 1976 et *Pseudochazara tisiphone* Brown, 1981 (Nymphalidae). Les trois équipes (CASMEK1, VVE1 et VVE2) ont contribué aux données de la distribution de la faune des papillons en Albanie.

Key words: Lepidoptera — Papilionoidea — *Limenitis camilla* — *Araschnia levana* — *Euphydryas maturna* — *Erebia alberganus* — *Spialia phlomidis* — *Colias aurorina* — *Apatura iris* — *Boloria titania* — *Melitaea diamina* — *Pseudochazara amymone* — *Pseudochazara tisiphone* — Albania — Distribution.

Bjerregård E. B.: Rebæk Søpark 5, 414, 2650 Hvidovre, Denmark. xanthomelas@live.dk

Bjerg M.: Hanehovedvej 154C, 330 Frederiksværk, Denmark. bjerg34@hotmail.com

Clausen A. B.: Gl. Københavnsvej 14, 3550 Slangerup Denmark. hegnstrup@hotmail.com

Dahl K.: Lathyrusvej 27, 3300 Frederiksværk, Denmark. sommerfugle@gmail.com

Glintborg S. P.: Porskaervej 5, 8600 Silkeborg, Denmark. spglintborg@gmail.com

Videnkjær C.: Lærkehaven 3, 2980 Kokkedal, Denmark. cuv@herlufsholm.dk

DOI: 10.6084/m9.figshare.22722871

Introduction

Albania is a country rich in biodiversity in the Balkans. But since the country was completely isolated for almost three decades from around 1960 to 1990 the butterfly fauna of the country has been poorly studied compared to most of the bordering countries: Kosovo, Montenegro, North Macedonia, and Greece. Albania is very mountainous and supports a rich butterfly fauna. Even though the butterfly fauna historically has been poorly studied the knowledge has been increasing in recent years. Most recently in 2017 two well-conducted surveys were carried out by two teams, VVE1 and VVE2 (Cuvelier *et al*. 2018), which managed to find four new species for Albania. In addition, they also made a lot of other interesting records, and DNA barcoding was carried out to provide information about

difficult taxa. Finally, they gathered all the historical information about the butterfly fauna in Albania and verified or rejected the data. Based on these investigations they published an updated Albanian checklist. Despite the thorough surveys by VVE1 and VVE2 teams (Cuvelier *et al*. 2018), they concluded that more new surveys were needed to elucidate the complete knowledge about the distribution of the butterflies of Albania. This survey, by CASMEK1 team, is a follow up on VVE1 and VVE2 results and the exploitation of the potential for discovering new species for Albania as well as for gathering additional, interesting records.

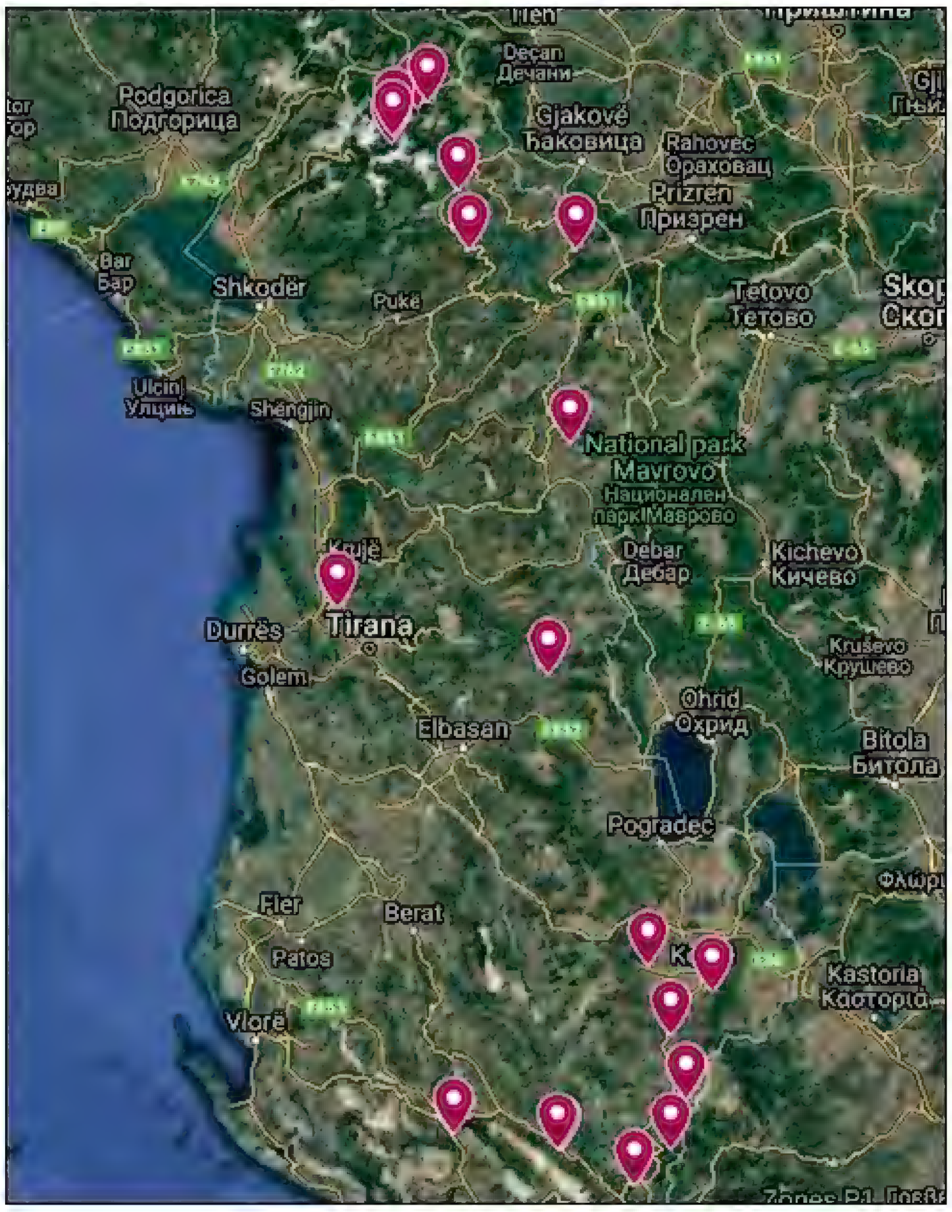


Fig. 1. Map of visited sites in Albania by CASMEK1 team.

The Danish survey from 2019 was arranged by Dansk Lepidopterologisk Forening and carried out by Emil Blicher Bjerregård, Martin Bjerg, Allan Bornø Clausen, Kaj Dahl, Søren Peter Glintborg and Christian Videnkjær; throughout this article this team will be referred to as CASMEK1 team, the initials of the participants' first names. The survey was carried out over 11 days, from 5.vii.2019 to 15.vii.2019 (Fig. 1). The first and last day were mainly spent travelling, which limited the survey on those days. From 6.vii.2019 to 8.vii.2019 the survey was carried out in Valbonë in northern Albania. An extremely rich butterfly fauna is to be found in the area and all the new species for Albania recorded by CASMEK1 team were found on those three days. 9.vii.2019 and 10.vii.2019 were mainly spent travelling from northern Albania to the south-eastern part of the country; and on these days the survey was not as systematic as for the first three days in Valbonë. From 11.vii.2019 to 14.vii.2019 the survey was carried out in south-eastern Albania, especially around Korçë.

Results

The most interesting records from the CASMEK1 survey were the discovery of four new species for Albania: *Limenitis camilla* (Linnaeus, 1764), *Araschnia levana* (Linnaeus, 1758), *Euphydryas maturna* (Linnaeus, 1758) and *Erebia alberganus phorcys* (Prunner, 1798). These four new species for Albania will be presented first and, subsequently, the additional records of *Spialia phlomidis* (Herrich-Schäffer, 1845), *Colias aurorina* Herrich-Schäffer, 1850, *Apatura iris* (Linnaeus, 1758), *Boloria titania* (Esper, 1793), *Melitaea diamina* (Lang, 1789), *Pseudochazara amymone* Brown, 1976 and *Pseudochazara tisiphone* Brown, 1981. All species are reviewed with maps, coordinates, images, data of collected butterflies and further information on observations. Results obtained from genitalia preparations and DNA barcoding are also reviewed.

Limenitis camilla (Linnaeus, 1764)
(Figs 2, 3, Table 1)

Fig. 2. *Limenitis camilla*, Gocaj, Valbonë 8.vii.2019. © Kaj Dahl.

Table 1. Sites for *Limenitis camilla*.

Sites	Date	Coordinates
Margjeka, Valbonë	6.vii.2019	42°25'20.9"N 19°52'24.2"E
Gocaj, Valbonë	6.vii.2019	42°29'47.3"N 19°57'01.6"E
Gocaj, Valbonë	8.vii.2019	42°29'47.3"N 19°57'01.6"E

Limenitis camilla (Nymphalidae) is widely distributed in Europe and known from most of the European countries. *Limenitis camilla* was erroneously included in the Albania list in 1972, but this proved to be a misidentified specimen of *Limenitis reducta* Staudinger, 1901. The possibility for the presence of *Limenitis camilla* in Albania was estimated as possible by VVE1 and VVE2 teams. *Limenitis camilla* is known from nearby localities in Montenegro, North Macedonia, and Greece.

CASMEK1 team succeeded in confirming *Limenitis camilla* for Albania. We found several sites for this species around Valbonë in the northern part of Albania. The first record for Albania of *Limenitis camilla* was a single

 ISSN 0771-5277

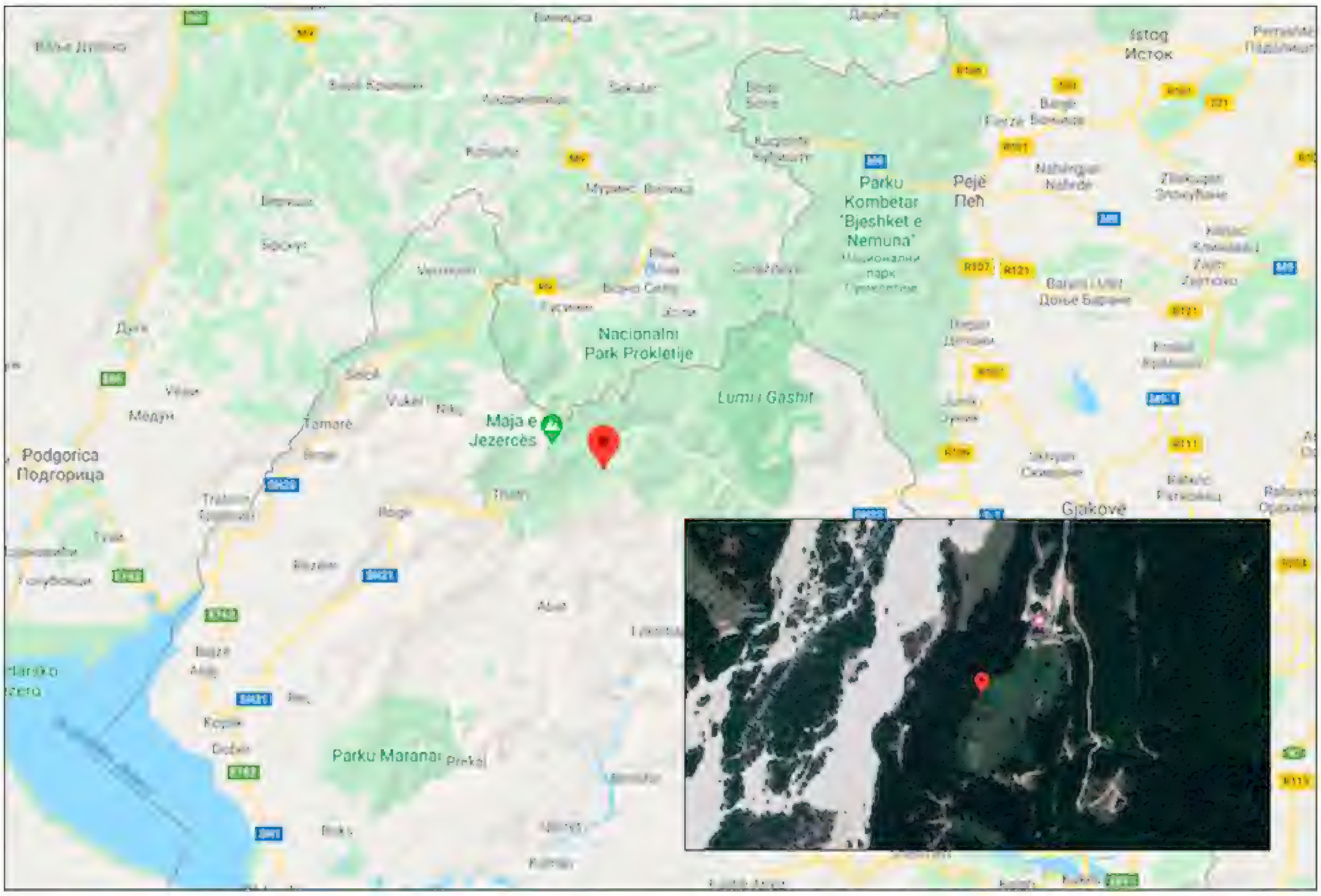


Fig. 3. The first record for Albania of *Limenitis camilla* near Margjeka, Valbonë, 6.vii.2019.

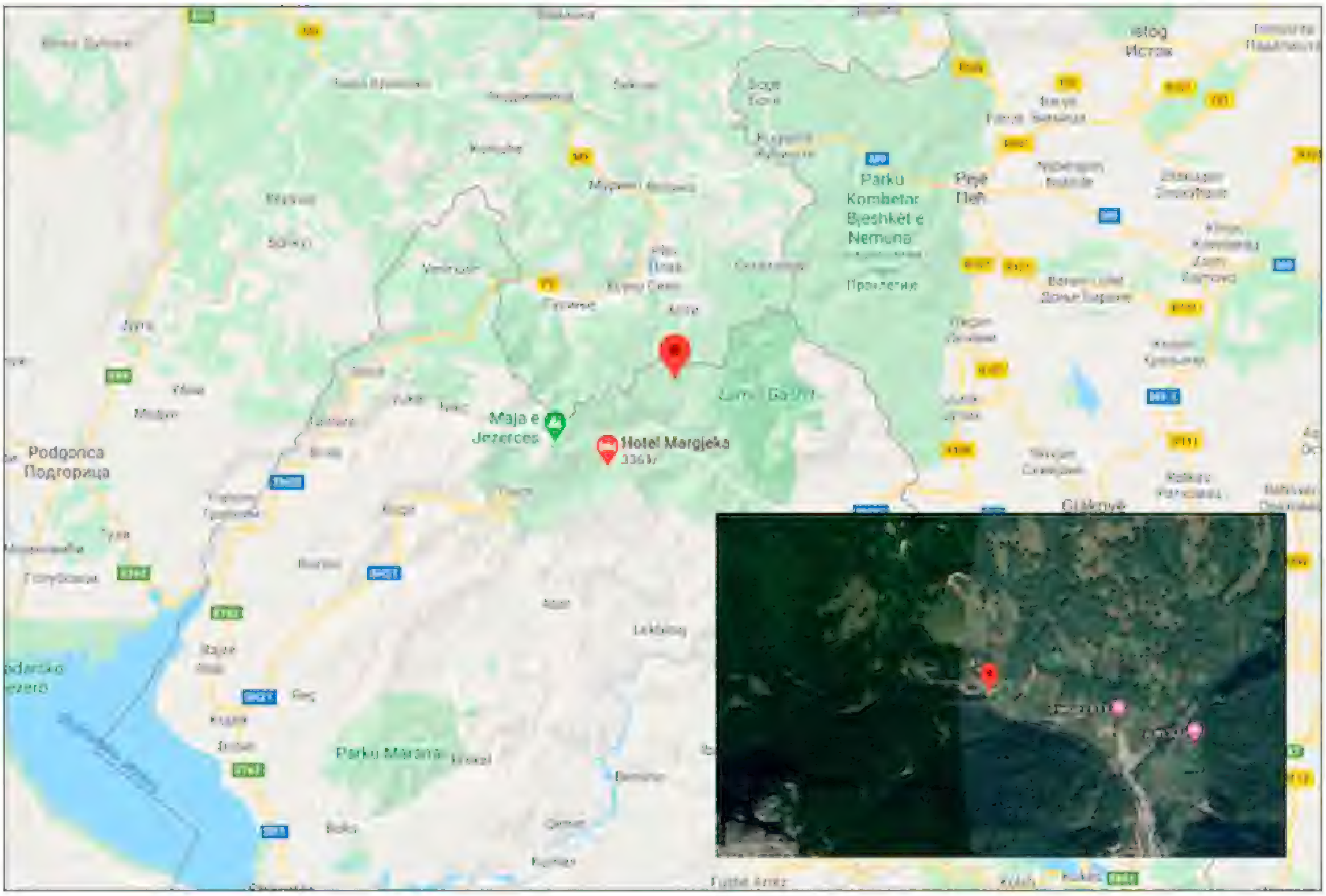


Fig. 4. First record for Albania of *Araschnia levana* near Gocaj, Valbonë 8.vii.2019.

specimen found at Margjeka, Valbonë and is shown on the map in Fig. 3. A strong population was found near Gocaj, Valbonë, 6.vii.2019 and 8.vii.2019 and the species was observed in numbers from the given coordinates and approximately two km to the south.

Araschnia levana (Linnaeus, 1758) (Figs 4, 5, Table 2)

Fig. 5. *Araschnia levana*, Gocaj, Valbonë 8.vii.2019. First record for Albania. © Martin Bjerg.

Table 2. Sites for *Araschnia levana*.

Sites	Date	Coordinates
Gocaj, Valbonë	8.vii.2019	42°29'47.3"N 19°57'01.6"E
Bujan, Tropojë	9.vii.2019	42°19'17.4"N 20°04'14.3"E

Araschnia levana (Nymphalidae) is widely distributed in Europe and known from most European countries. Albania is right on the southern boundary of the species. According to VVE1 and VVE2 records, there was potential for *Araschnia levana* in northern Albania. VVE1 team found three specimens near Brëzne in Kosovo, approximately five km from the eastern border of Albania. Furthermore, the species has spread in both Macedonia and Greece in recent decades. CASMEK1 team found two specimens of *Araschnia levana* at two different sites, both in northern Albania. The first record of *Araschnia levana* was a single specimen found near Gocaj, Valbonë, 8.vii.2019. It was discovered at the same locality where *Euphydryas maturna* was found. The second specimen of *Araschnia levana* was found near Bujan, Tropojë, approximately 22 km southeast of the first locality near Gocaj in Valbonë. The exact location for the first record of *Araschnia levana* for Albania is shown on the map in Fig. 4. The coordinates for both records are shown in Table 2.

Euphydryas maturna (Linnaeus, 1758) (Figs 6, 7, Table 3)

Euphydryas maturna (Nymphalidae) is a local species in Europe. It is rare in Scandinavia, absent in southwestern Europe, but widely distributed in central, eastern, and south-eastern Europe. In Albania *Euphydryas maturna* was first listed by Murraj (1972). Many other authors have since mentioned *E. maturna* from Albania, but according to Sachanowicz *et al.* (2016) the species should not figure on the Albanian checklist. The only specimen known from Albania did not have any label with the location and date. The specimen is in the collection of the Museum of Natural History in Tiranë. No specimens were found by VVE1 and VVE2 teams.

Fig. 6. *Euphydryas maturna*, Gocaj, Valbonë 6.vii.2019. First record for Albania. © Emil Blicher Bjerregård.

Table 3. Sites for *Euphydryas maturna*.

Sites	Date	Coordinates
Gocaj, Valbonë	6.vii.2019	42°29'47.3"N 19°57'01.6"E
Gocaj, Valbonë	8.vii.2019	42°29'47.3"N 19°57'01.6"E

In 2019 CASMEK1 team found a population of *Euphydryas maturna* near Gocaj, Valbonë. The first specimen was found the evening of 6.vii.2019; the first new record for Albania. On 8.vii.2019 CASMEK1 revisited the locality and confirmed the presence of a population, when approximately 15 specimens were found.

Erebia alberganus (Prunner, 1798) (Figs 8, 9, Table 4)

The distribution of this species is limited to the Alps, nearby sites in France, Italy, and in the Balkans. In the Balkans, the subspecies *Erebia alberganus phorcys* (Freyer, 1836) is present. No specimens were found by VVE1 and VVE2 teams. We found *Erebia alberganus* as a new species for Albania at Kukaj, Valbonë on 7.vii.2019. Only one specimen was found. *E. alberganus phorcys* is also present in the nearby countries of Bosnia and Herzegovina, Serbia, Bulgaria, and North Macedonia.

Table 4. Sites for *Erebia alberganus*.

Sites	Date	Coordinates
Kukaj, Valbonë	7.vii.2019	42°27'43.1"N 19°52'42.6"E

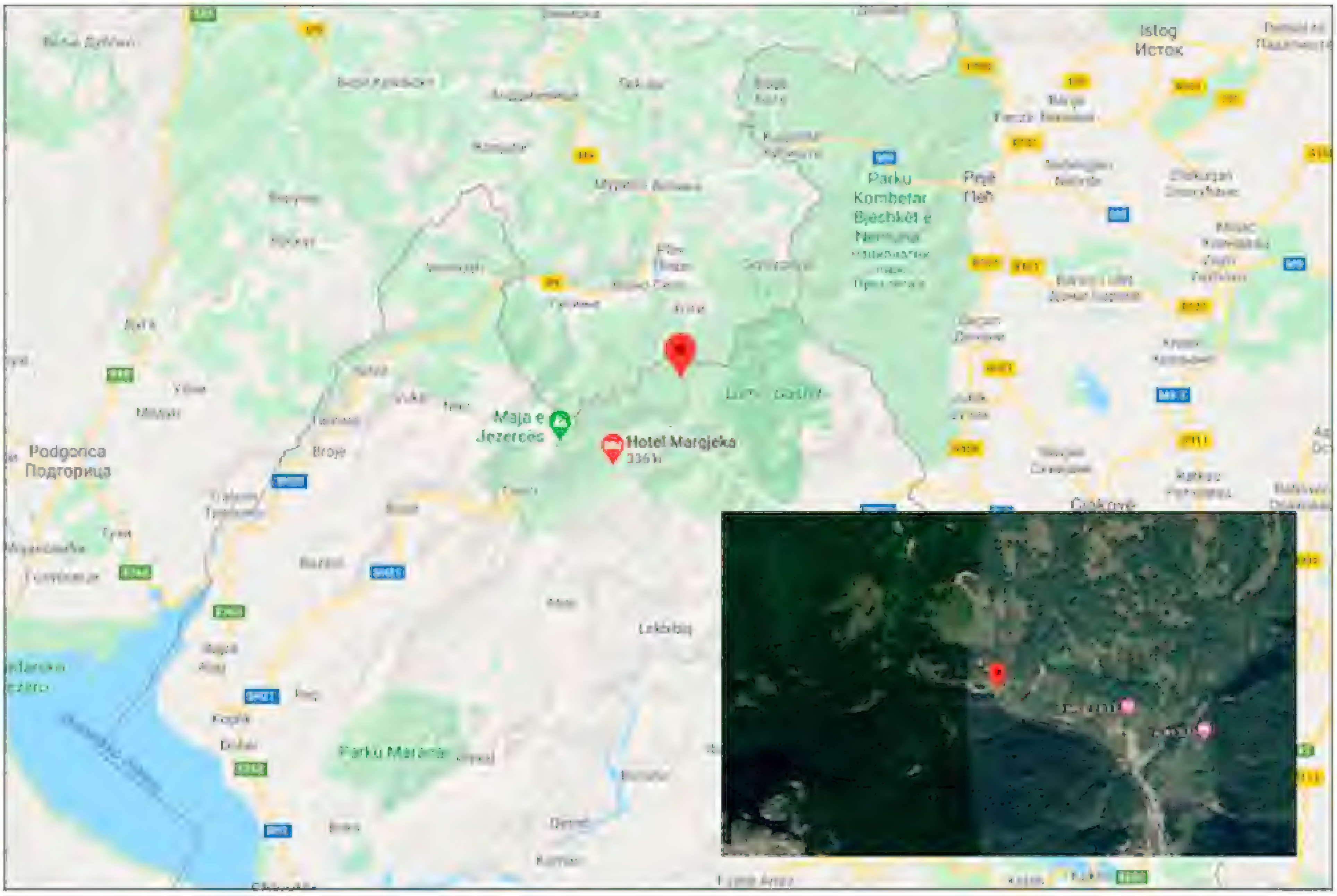


Fig. 7. First record for Albania of *Euphydryas maturna* near Gocaj, Valbonë 6.vii.2019.

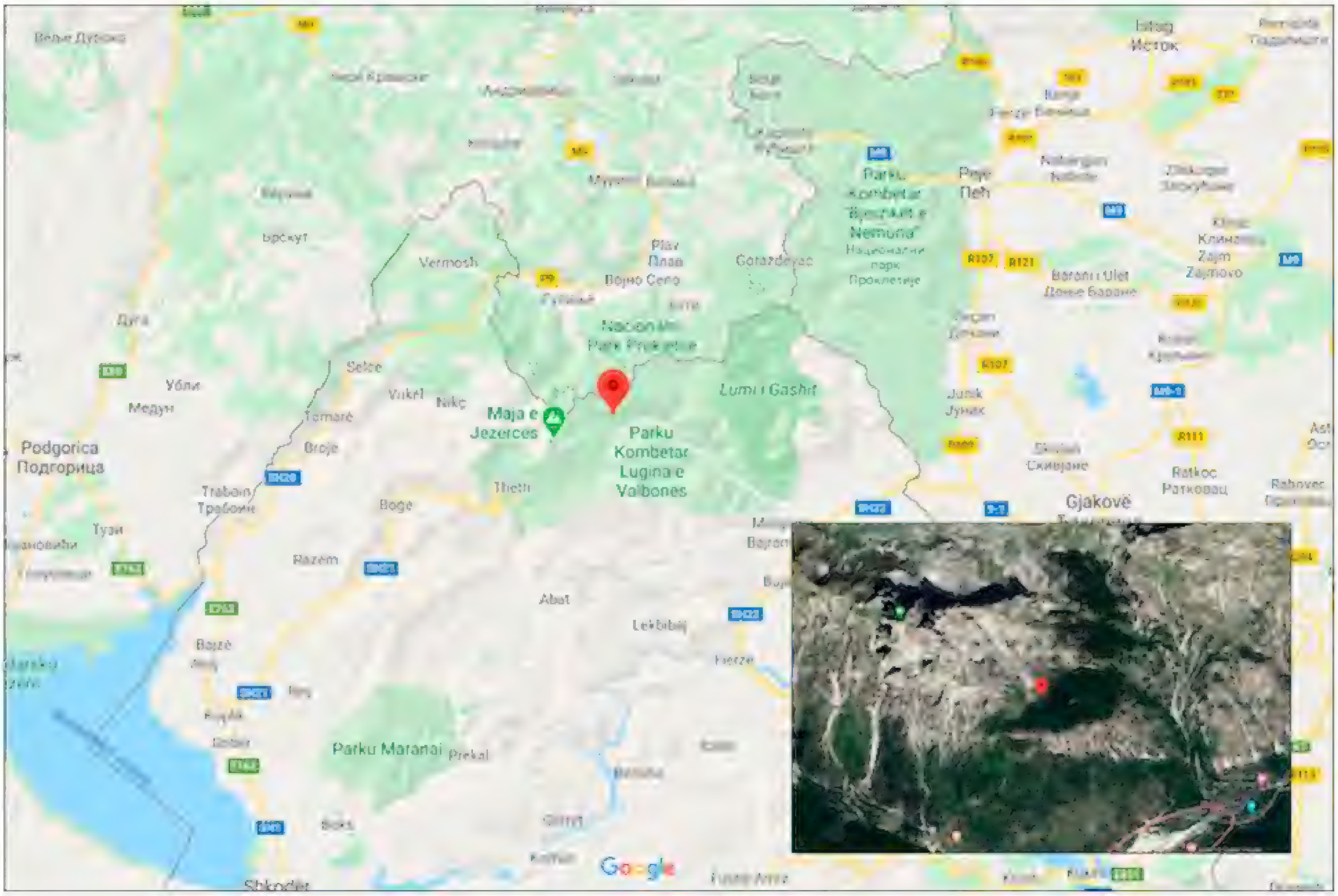


Fig. 8. First record for Albania of *Erebia alberganus* near Kukaj, Valbonë 7.vii.2019.

Fig. 9. First record for Albania of *Erebia alberganus phorcys* near Kukaj, Valbonë 7.vii.2019, leg. Søren Peter Glintborg, Emil Blicher Bjerregård and Allan Bornø Clausen. Coll. Søren Peter Glintborg. © Søren Peter Glintborg

Additional records

In addition to the four new species found for Albania, CASMEK1 team also managed to make a number of other interesting observations, recording a total of 136 butterfly species present. The most interesting species that the team recorded are presented individually, followed by the total list of observed species compiled by the CASMEK1 team.

Spialia phlomidis (Herrich-Schäffer, 1845) (Figs 10, 11, Table 5)

Fig. 10. *Spialia phlomidis*, Pepellash, Qafa e Qarrit, 11.vii.2019. © Kaj Dahl.

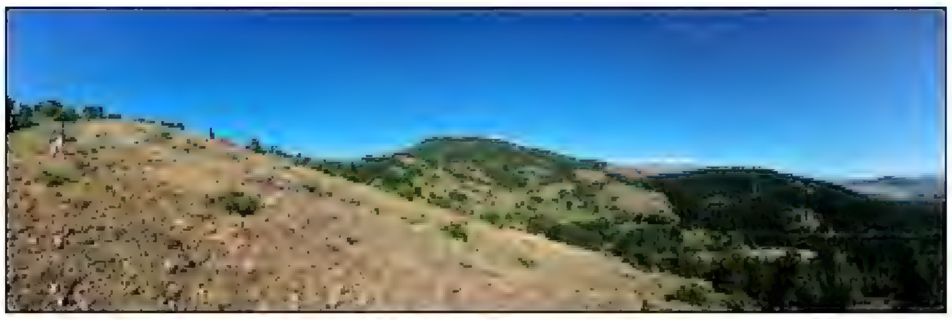


Fig. 11. Habitat for *Spialia phlomidis*, Pepellash, Qafa e Qarrit, 11.vii.2019. © Emil Blicher Bjerregård.

Table 5. Sites for *Spialia phlomidis*.

Sites	Date	Coordinates
Pepellash, Qafa e Qarrit	11.vii.2019	40°28'44.5"N 20°40'41.6"E
Sarandoporo, Korçë	13.vii.2019	40°05'39.0"N 20°37'31.3"E

Spialia phlomidis (Hesperiidae) is a local and rare species in Europe. The European distribution is mainly limited to the Balkans and nearby countries with populations in European Russia, Bulgaria, North Macedonia, European Turkey, Greece, and Albania.

VVE1 and VVE2 teams did not find any specimens of *Spialia phlomidis,* but the species is known from a few sites in the north-eastern and western parts of Albania and a single site in the southern part. CASMEK1 team found two new sites for *Spialia phlomidis*. A local population was found near Pepellash, Qafa e Qarrit, 11.vii.2019 where approximately 10 individuals were found. A single specimen was found near Sarandoporo, Korçë.

Colias aurorina Herrich-Schäffer, 1850 (Figs 12, 13, Table 6)

Fig. 12. *Colias aurorina heldreichii* f. *fountanei*, Rehovë, Ersekë, 12.vii.2019. © Emil Blicher Bjerregård.

 ISSN 0771-5277

Fig. 22. Habitat for *Colias aurorina heldreichii* near Rehovë, Ersekë, 12.vii.2019. © Emil Blicher Bjerregård

Table 6. Sites for *Colias aurorina*.

Sites	Date	Coordinates
Rehovë, Ersekë	12.vii.2019	40°20'19.1"N 20°43'31.2"E

Colias aurorina heldreichii (Staudinger, 1862) is the European subspecies of the widely distributed nominotypical *Colias aurorina* Herrich-Schäffer, 1850 (Pieridae). The subspecies *C. aurorina heldreichii* was described from Greece. It was thought to be endemic to Greece, but in 2012 it was discovered in Albania (Verovnik & Popović 2013). In 2019 CASMEK1 team confirmed the species' presence in south-eastern Albania. Approximately 30–40 individuals of *C. aurorina* were found at Rehovë, Ersekë at exactly the same location where *C. aurorina* was first found for Albania in 2012.

Apatura iris (Linnaeus, 1758) (Fig. 14, Table 7)

Fig. 14. *Apatura iris*, Gocaj, Valbonë, 8.vii.2019, leg. Emil Blicher Bjerregård, Søren Peter Glintborg & Christian Videnkjær. Coll. Søren Peter Glintborg. © Søren Peter Glintborg.

Table 7. Sites for *Apatura iris*.

Sites	Date	Coordinates
Gocaj, Valbonë	8.vii.2019	42°29'42.9"N 19°57'07.3"E
Gërmenji, Korçë	13.vii.2019	40°13'32.3"N 20°39'36.8"E

In 2017 VVE1 team found a single specimen on Qafa Buni in northern Albania. VVE1 team was unsure if it was a migrating individual or had originated from a resident population. *Apatura iris* (Nymphalidae) is known from a few more sites in south-eastern Albania. In 2019 CASMEK1 team found two specimens of *Apatura iris* in Albania. The first specimen was found at Gocaj, Valbonë in northern Albania, being only the second record for the northern part of Albania. The second specimen found by CASMEK1 team was at Gërmenji in south-eastern Albania.

Boloria titania (Esper, [1793]) (Fig. 15, Table 8)

Fig. 15. *Boloria titania*, Çerem, Valbonë, 8.vii.2019. © Emil Blicher Bjerregård.

Table 8. Sites for *Boloria titania*.

Sites	Date	Coordinates
Çerem, Valbonë	8.vii.2019	42°30'36.9"N 19°59'17.6"E

The distribution of the subspecies *Boloria titania cypris* (Meigen, 1828) (Nymphalidae) is limited to the Balkans and the Alps. In the remaining parts of Europe, the nominotypical *Boloria titania titania* is distributed in Massif Central, Alpes-Maritimes in south-eastern France to north-western Italy. The species is also distributed in southern Finland, Estonia, Latvia, and European Russia as subspecies *Boloria titania bivina* (Fruhstorfer, 1908). In 2017 VVE1 team found a local population near Çerem, Valbonë in northern Albania. In 2019 its presence near Çerem was confirmed by CASMEK1 team. We found the species at exactly the same place as VVE1 team and can confirm that the population is strong and local. Many nearby areas were searched without any sightings of *Boloria titania*.

Melitaea diamina (Lang, 1789) (Fig. 16, Table 9)

Fig. 16. Habitat for *Melitaea diamina* near Çerem, Valbonë, 6.vii.2019. © Emil Blicher Bjerregård.

Table 9. Sites for *Melitaea diamina*.

Sites	Date	Coordinates
Gocaj, Valbonë	6.vii.2019	42°27'40.1"N 19°56'50.7"E
Çerem, Valbonë	8.vii.2019	42°30'36.9"N 19°59'17.6"E

The species is only known from very few sites in Albania. *Melitaea diamina* (Nymphalidae) was first described from Albania by Sachanowicz *et al*. (2016), when two populations were found in northern Albania. In 2017 VVE1 team found a strong population of *Melitaea diamina* at Çerem, Valbonë. In 2019 its presence near Çerem was confirmed by CASMEK1 team. We found the species at exactly the same site as VVE1 team. A new site for *Melitaea diamina was* also found by CASMEK1 team near Gocaj.

***Pseudochazara amymone* Brown, 1976 (Figs 17, 19, 20, Table 10)**

Fig. 17. *Pseudochazara amymone*, Pepellash, Qafa e Qarrit, 11.vii.2019. © Martin Bjerg.

Fig. 10. Sites *for Pseudochazara amymone*.

Sites	Date	Coordinates
Drenovë, Korçë	11.vii.2019	40°34'29.3"N 20°47'59.5"E
Pepellash, Qafa e Qarrit	11.vii.2019	40°28'44.5"N 20°40'41.6"E

Pseudochazara amymone (Nymphalidae) is one of the most mysterious butterflies in Europe. Prior to 2010, the only information available on *P. amymone* was as follows: four specimens captured in north-western Greece, at Ioánnina, between the 5–10. July 1975; a single female also captured at Ioánnina, a few years later; and a specimen captured at Pepellash, Qafa e Qarrit in Albania in 1979. It was John Brown who found the first five specimens in Greece, and Kastriot Misja who found a specimen in Albania. In 2010, however, the species was rediscovered in south-eastern Albania, near Korçë. Finally, DNA barcoding has also shown that *P. amymone* is a separate species from *Pseudochazara mamurra* (Herrich-Schäffer, 1852) (Verovnik & Wiemers 2016). The distribution record in Albania for *P. amymone* found by Kastriot Misja was the only record known until recently.

Pseudochazara amymone was recorded from two different sites in Albania by CASMEK1 team. Two specimens were found at Drenovë, Korçë which is a known site for *P. amymone* and a single specimen was found a Pepellash, Qafa e Qarrit. At this site *P. amymone* was first found in Albania in 1979 but has not been reported from here since until this record by the CASMEK1 team.

***Pseudochazara tisiphone* Brown, [1981] (Figs 18, 19, Table 11)**

Fig. 18. *Pseudochazara tisiphone*, Pepellash, Qafa e Qarrit, 11.vii.2019. © Kaj Dahl.

Fig. 19. Pepellash, Qafa e Qarrit, 11.vii.2019. Habitat for *Pseudochazara amymone* and *Pseudochazara tisiphone*. © Emil Blicher Bjerregård.

Table 11. Sites for *Pseudochazara tisiphone*.

Sites	Date	Coordinates
Drenovë, Korçë	11.vii.2019	40°34'29.3"N 20°47'59.5"E
Pepellash, Qafa e Qarrit	11.vii.2019	40°28'44.5"N 20°40'41.6"E

Before 2016 this taxon was cited as a subspecies *Pseudochazara tisiphone* of *Pseudochazara mniszechii* (Herrich-Schaffer, [1851]) (Nymphalidae), widely distributed in Turkey. The taxonomical status of the genus *Pseudochazara* de Lesse, 1951 was examined by Takáts & Mølgaard (2016) and Verovnik & Wiemers (2016). DNA barcoding was used to provide information about the genus and to separate the species *P. mniszechii* and *P. tisiphone*. Using the molecular approach also *Pseudochazara amymone* and the Middle East species *Pseudochazara mamurra* were separated.

VVE1 team discovered a well-established population of *Pseudochazara tisiphone* around Bulqizë, Dibër and VVE2 team also observed *P. tisiphone* in the same area.

CASMEK1 team confirmed the strong population of this species at Drenovë, Korçë. A new, extremely strong population was also found near Pepellash, Qafa e Qarrit, where hundreds of specimens were found.

Conclusion

CASMEK1 survey was a follow up on VVE1 and VVE2 results. Four new species were found for Albania in just a single survey of 11 days ranging from 5.vii.2019 to 15.vii.2019, even though only a very small part of the country was investigated. It seems likely that several undiscovered species are still to be found considering that VVE1 and VVE2 teams also managed to find four new species in just two surveys in 2017. The Albanian butterfly checklist now contributes 200 species after the investigation in 2019 by CASMEK1 team. The Albanian checklist can be consulted in 'Checklist' below which is based on the previous checklist compiled by VVE1 and VVE2 teams. The nomenclature follows *'An updated checklist of the European Butterflies (Lepidoptera, Papilionoidea)'* (Wiemers *et al*. 2018). The 136 species in bold are the species found by CASMEK1 team.

Acknowledgements

We are thankful to Sylvain Cuvelier, Laurian Parmentier, Jurgen Couckuyt, Thomas Maertens, Delphine Vincke and Anila Paparisto from VVE1 and VVE2 teams for their inspirational research. We are especially grateful to Prof. Kastriot Misja who managed to provide information about the Albanian butterfly fauna for decades in a completely isolated country. We are also thankful to Flemming Vilhelmsen for examination of genitalia and to Galina Kuftina for examination of DNA to confirm the determination of some Pieridae species.

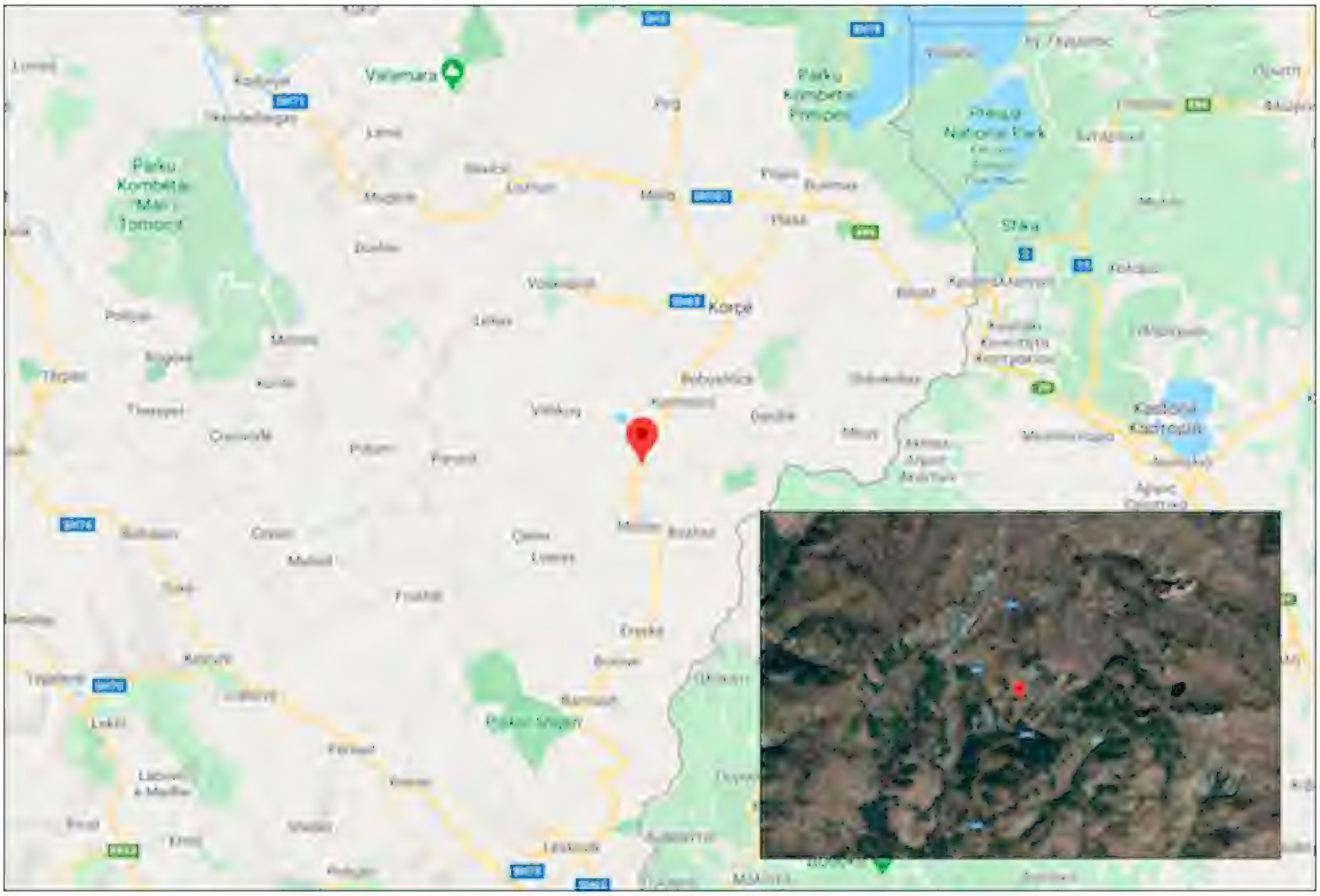


Fig. 20. Locality for *Pseudochazara amymone* near Pepellash, Qafa e Qarrit. The record by CASMEK1 was the first record since 1979 from Pepellash.

Checklist of butterflies of Albania

Papilionidae	*Euchloe ausonia* (Hübner, [1804])
Papilioninae	*Euchloe penia* (Freyer, 1851)
Iphiclides podalirius (Linnaeus, 1758)	***Pontia edusa*** (Fabricius, 1777)
Papilio alexanor Esper, 1800	*Pieris balcana* Lorković, [1969]
Papilio machaon Linnaeus, 1758	***Pieris brassicae*** (Linnaeus, 1758)
Parnassiinae	***Pieris ergane*** (Geyer, [1828])
Parnassius apollo (Linnaeus, 1758)	*Pieris krueperi* Staudinger, 1860
Parnassius mnemosyne (Linnaeus, 1758)	***Pieris mannii*** (Mayer, 1851)
Zerynthia cerisy (Godart, [1824])	***Pieris napi*** (Linnaeus, 1758)
Zerynthia polyxena ([Denis & Schiffermüller], 1775)	***Pieris rapae*** (Linnaeus, 1758)
Hesperiidae	**Riodinidae**
Heteropterinae	**Nemeobiinae**
Carterocephalus palaemon (Pallas, 1771)	***Hamearis lucina*** (Linnaeus, 1758)
Hesperiinae	**Lycaenidae**
Gegenes nostrodamus (Fabricius, 1793)	**Lycaeninae**
Gegenes pumilio (Hoffmansegg, 1804)	***Lycaena alciphron*** (Rottemburg, 1775)
Hesperia comma (Linnaeus, 1758)	***Lycaena candens*** (Herrich-Schäffer, 1844)
Ochlodes sylvanus (Esper, 1777)	***Lycaena dispar*** ([Haworth], 1802)
Thymelicus action (Rottemburg, 1775)	*Lycaena ottomana* (Lefèbvre, [1831])
Thymelicus lineola (Ochsenheimer, 1808)	***Lycaena phlaeas*** (Linnaeus, [1760])
Thymelicus sylvestris (Poda, 1761)	*Lycaena thersamon* (Esper, 1784)
Pyrginae	***Lycaena tityrus*** (Poda, 1761)
Carcharodus alceae (Esper, 1780)	***Lycaena virgaureae*** (Linnaeus, 1758)
Carcharodus floccifera (Zeller, 1847)	**Theclinae**
Carcharodus lavatherae (Esper, 1783)	***Callophrys rubi*** (Linnaeus, 1758)
Carcharodus orientalis Reverdin, 1913	***Favonius quercus*** (Linnaeus, 1758)
Erynnis marloyi (Boisduval, 1834)	***Satyrium acaciae*** (Fabricius, 1787)
Erynnis tages (Linnaeus, 1758)	***Satyrium ilicis*** (Esper, 1779)
Muschampia proto (Ochsenheimer, 1808)	***Satyrium spini*** ([Denis & Schiffermüller], 1775)
Pyrgus alveus (Hübner, [1803])	***Satyrium w-album*** (Knoch, 1782)
Pyrgus andromedae (Wallengren, 1853)	***Thecla betulae*** (Linnaeus, 1758)
Pyrgus armoricanus (Oberthür, 1910)	**Polyommatinae**
Pyrgus carthami (Hübner, [1813])	***Aricia agestis*** ([Denis & Schiffermüller], 1775)
Pyrgus cinarae (Rambur, 1839)	*Cacyreus marshalli* Butler, 1898
Pyrgus malvae (Linnaeus, 1758)	***Celastrina argiolus*** (Linnaeus, 1758)
Pyrgus serratulae (Rambur, 1839)	***Cyaniris semiargus*** (Rottemburg, 1775)
Pyrgus sidae (Esper, 1784)	***Cupido alcetas*** (Hoffmansegg, 1804)
Spialia phlomidis (Herrich-Schäffer, 1845)	***Cupido argiades*** (Pallas, 1771)
Spialia orbifer (Hübner, [1823])	*Cupido decoloratus* (Staudinger, 1886)
Pieridae	***Cupido minimus*** (Fuessly, 1775)
Dismorphiinae	***Cupido osiris*** (Meigen, 1829)
Leptidea duponcheli (Staudinger, 1871)	***Cyaniris semiargus*** (Rottemburg, 1775)
Leptidea sinapis (Linnaeus, 1758)	***Eumedonia eumedon*** (Esper, 1780)
Coliadinae	***Glaucopsyche alexis*** (Poda, 1761)
Colias alfacariensis Ribbe, 1905	***Iolana iolas*** (Ochsenheimer, 1816)
Colias aurorina Herrich-Schäffer, 1850	*Kretania sephirus* (Frivaldszky, 1835)
Colias croceus (Geoffroy, 1785)	***Lampides boeticus*** (Linnaeus, 1767)
Colias caucasica Staudinger, 1871	***Leptotes pirithous*** (Linnaeus, 1767)
Gonepteryx cleopatra (Linnaeus, 1767)	***Lysandra bellargus*** (Rottemburg, 1775)
Gonepteryx farinosa (Zeller, 1847)	***Lysandra coridon*** (Poda, 1761)
Gonepteryx rhamni (Linnaeus, 1758)	***Phengaris alcon*** ([Denis & Schiffermüller], 1775)
Pierinae	***Phengaris arion*** (Linnaeus, 1758)
Anthocharis cardamines (Linnaeus, 1758)	*Plebejus argus* (Linnaeus, 1758)
Anthocharis damone Boisduval, 1836	***Plebejus argyrognomon*** (Bergsträsser, 1779)
Anthocharis gruneri Herrich-Schäffer, 1851	***Plebejus idas*** (Linnaeus, [1760])
Aporia crataegi (Linnaeus, 1758)	***Polyommatus admetus*** (Esper, 1783)

Continued	
Polyommatus amandus (Schneider, 1792)	**Danainae**
Polyommatus damon ([Denis & Schiffermüller], 1775)	*Danaus chrysippus* (Linnaeus, 1758)
Polyommatus daphnis ([Denis & Schiffermüller], 1775)	**Charaxinae**
Polyommatus dorylas ([Denis & Schiffermüller], 1775)	*Charaxes jasius* (Linnaeus, 1767)
Polyommatus eros (Ochsenheimer, 1808)	**Satyrinae**
Polyommatus escheri (Hübner, [1823])	***Aphantopus hyperantus*** (Linnaeus, 1758)
Polyommatus icarus (Rottemburg, 1775)	*Arethusana arethusa* ([Denis & Schiffermüller], 1775)
Polyommatus ripartii (Freyer, 1830)	***Brintesia circe*** (Fabricius, 1775)
Polyommatus thersites (Cantener, 1835)	***Chazara briseis*** (Linnaeus, 1764)
Pseudophilotes vicrama (Moore, 1865)	***Coenonympha arcania*** (Linnaeus, [1760])
Scolitantides orion (Pallas, 1771)	*Coenonympha leander* (Esper, 1784)
Tarucus balkanicus (Freyer, 1844)	***Coenonympha orientalis*** Rebel, 1909
Nymphalidae	***Coenonympha pamphilus*** (Linnaeus, 1758)
Limenitidinae	***Coenonympha rhodopensis*** Elwes, 1900
Limenitis camilla (Linnaeus, 1764)	***Erebia aethiops*** (Esper, 1777)
Limenitis reducta Staudinger, 1901	***Erebia alberganus*** (Prunner, 1798)
Heliconiinae	*Erebia cassioides* (Hohenwarth, 1792)
Argynnis pandora ([Denis & Schiffermüller], 1775)	*Erebia epiphron* (Knoch, 1783)
Argynnis paphia (Linnaeus, 1758)	*Erebia euryale* (Esper, 1805)
Boloria dia (Linnaeus, 1767)	*Erebia gorge* (Hübner, [1804])
Boloria euphrosyne (Linnaeus, 1758)	***Erebia ligea*** (Linnaeus, 1758)
Boloria graeca (Staudinger, 1870)	*Erebia medusa* ([Denis & Schiffermüller], 1775)
Boloria pales ([Denis & Schiffermüller], 1775)	*Erebia melas* (Herbst, 1796)
Boloria titania (Esper, [1793])	***Erebia oeme*** (Hübner, [1804])
Brenthis daphne ([Denis & Schiffermüller], 1775)	***Erebia ottomana*** Herrich-Schäffer, 1847
Brenthis hecate ([Denis & Schiffermüller], 1775)	*Erebia pandrose* (Borkhausen, 1788)
Brenthis ino (Rottemburg, 1775)	*Erebia pronoe* (Esper, 1780)
Fabriciana adippe ([Denis & Schiffermüller], 1775)	*Erebia rhodopensis* Nicholl, 1900
Fabriciana niobe (Linnaeus, 1758)	*Erebia triarius* (Prunner, 1798)
Issoria lathonia (Linnaeus, 1758)	***Hipparchia fagi*** (Scopoli, 1763)
Speyeria aglaja (Linnaeus, 1758)	*Hipparchia fatua* Freyer, 1843
Apaturinae	*Hipparchia semele* (Linnaeus, 1758)
Apatura ilia ([Denis & Schiffermüller], 1775)	*Hipparchia statilinus* (Hufnagel, 1766)
Apatura iris (Linnaeus, 1758)	*Hipparchia senthes* (Fruhstorfer, 1908)
Apatura metis Freyer, 1829	*Hipparchia syriaca* (Staudinger, 1871)
Nymphalinae	*Hipparchia volgensis* (Mazokhin-Porshnyakov, 1952)
Aglais io (Linnaeus, 1758)	*Hyponephele lupina* (Costa, 1836)
Aglais urticae (Linnaeus, 1758)	***Hyponephele lycaon*** (Kühn, 1774)
Araschnia levana (Linnaeus, 1758)	*Kirinia roxelana* (Cramer, 1777)
Euphydryas aurinia (Rottemburg, 1775)	***Lasiommata maera*** (Linnaeus, 1758)
Euphydryas maturna (Linnaeus, 1758)	***Lasiommata megera*** (Linnaeus, 1767)
Melitaea athalia (Rottemburg, 1775)	*Lasiommata petropolitana* (Fabricius, 1787)
Melitaea cinxia (Linnaeus, 1758)	***Maniola jurtina*** (Linnaeus, 1758)
Melitaea diamina (Lang, 1789)	***Melanargia galathea*** (Linnaeus, 1758)
Melitaea didyma (Esper, 1778)	***Melanargia larissa*** (Geyer, [1828])
Melitaea ornata Christoph, 1893	*Melanargia russiae* (Esper, 1783)
Melitaea phoebe ([Denis & Schiffermüller], 1775)	*Minois dryas* (Scopoli, 1763)
Melitaea trivia ([Denis & Schiffermüller], 1775)	***Pararge aegeria*** (Linnaeus, 1758)
Nymphalis antiopa (Linnaeus, 1758)	***Proterebia phegea*** (Borkhausen, 1788)
Nymphalis polychloros (Linnaeus, 1758)	***Pseudochazara amalthea*** (Frivaldszky, 1845)
Nymphalis xanthomelas ([Denis & Schiffermüller], 1775)	***Pseudochazara amymone*** Brown, 1976
Polygonia egea (Cramer, 1775)	*Pseudochazara geyeri* (Herrich-Schäffer, 1846)
Polygonia c-album (Linnaeus, 1758)	***Pseudochazara tisiphone*** Brown, [1981]
Vanessa atalanta (Linnaeus, 1758)	***Pyronia cecilia*** (Vallantin, 1894)
Vanessa cardui (Linnaeus, 1758)	***Pyronia tithonus*** (Linnaeus, 1771)
Libytheinae	***Satyrus ferula*** (Fabricius, 1793)
Libythea celtis (Laicharting, 1782)	

Literature

Cuvelier S., Parmentier L., Paparisto A. & Couckuyt J. 2018. Butterflies of Albania - Fluturat e Shqipërisë. New surveys, new species and e new checklist (Lepidoptera: Papilionoidea). — *Phegea* **46**(2): 48–69. http://www.phegea.org/Phegea/2018/Phegea46-2_48-69.pdf

Murraj X. 1972. Les papillons du jour en Albanie (Rhopalocera). — *Buletini i Shkencave të Natyrës* **3–4**: 83–107.

Sachanowicz K., Luczkowski S. & Larysz A. 2016. State of Knowledge of Butterfly Fauna of Albania, with Three New Species for the Country. — *Acta zoologica bulgarica* **68**(4): 511–518.

Takáts K. & Mølgaard M. 2016. Partial mtCOI-sequences of Balkanic species of *Pseudochazara* (Lepidoptera: Nymphalidae, Satyrinae) reveal three well-differentiated lineages. — *Entomologica romanica* **19**: 21–40.

Verovnik R. & Popović M. 2013a. First record of the Greek Clouded Yellow (*Colias aurorina* Herrich-Schäffer, 1850) for Albania. — *Natura Sloveniae* **15**: 27–32.

Verovnik R. & Wiemers M. 2016. Species delimitation in the Grayling genus *Pseudochazara* (Lepidoptera, Nymphalidae, Satyrinae) supported by DNA barcodes. — *ZooKeys* **600**: 131–154. https://zookeys.pensoft.net/article/7798/

Wiemers M., Balletto E., Dincă V., Frica F. Z., Lamas G., Lukhtanov V., Munguira L. M., van Swaay C. A. M., Vila R., Vliegenthart A., Wahlberg N. & Verovnik R. 2018. An updated checklist of the European Butterflies (Lepidoptera, Papilionoidea). *ZooKeys* **811**: 9–45. https://zookeys.pensoft.net/article/28712/

Corrigendum

Phegea 50(4): Laurian Parmentier "Contribution to the butterfly (Rhopalocera) fauna of Albania with confirmation of the presence of the black hairstreak *Satyrium pruni* (Papilionoidea: Lycaenidae) in the country" on p. 162: *recte* 'the Republic of North Macedonia'.

Is Sicily an island too far for *Papilio saharae*? Why is *Papilio machaon* rushed in where *P. saharae* is feared to tread? (Lepidoptera: Papilionidae)

Louis-F. Cassar

Abstract. *Papilio saharae* Oberthür, 1879 (Papilionidae) was reported from Sicily on a handful of occasions in the last decade or so. On at least two instances, the taxon was claimed to have been discovered in museum collections, respectively by Moonen (2012) at the Zoological Museum, Amsterdam (ZMA) and Leraut (2016) at the Muséum National d'Histoire Naturelle in Paris. These records and a proposed nomenclatural change for *P. machaon melitensis*, were subsequently rejected by Coutsis *et al.* (2018). The present contribution provides a critique of the methodologies employed by the various authors and acknowledges that there remains much scope to investigate the *P. machaon*-complex further while maintaining that a more holistic approach is required to better understand the multidimensional dynamics that have shaped the biogeography of the central Mediterranean area.

Samenvatting. *Papilio saharae* Oberthür, 1879 (Papilionidae) werd de afgelopen tien jaar een paar keer gemeld uit Sicilië. Bij ten minste twee gelegenheden werd beweerd dat het taxon in museumcollecties was ontdekt, respectievelijk door Moonen (2012) in het Zoölogisch Museum, Amsterdam (ZMA) en Leraut (2016) in het Muséum National d'Histoire Naturelle in Parijs met daaropvolgende nomenclatuurwijziging van *P. machaon melitensis* die later werd verworpen door Coutsis *et al.* (2018). In deze bijdrage wordt kritiek geleverd op de door de verschillende auteurs gebruikte methodologieën en wordt erkend dat er nog veel ruimte is om het *P. machaon*-complex verder te onderzoeken, terwijl een meer holistische benadering nodig is om de multidimensionale dynamiek die de biogeografie van het centrale Middellandse Zeegebied heeft gevormd, beter te begrijpen.

Résumé. *Papilio saharae* (Papilionidae) a été signalé en Sicile à plusieurs occasions au cours de la dernière décennie environ. À deux reprises au moins, le taxon a été déclaré découvert dans des collections de musées, respectivement par Moonen (2012) au Musée zoologique d'Amsterdam (ZMA) et Leraut (2016) au Muséum national d'histoire naturelle de Paris avec un changement de nomenclature ultérieur qui a ensuite été rejeté par Coutsis *et al.* (2018). La présente contribution fournit une critique des méthodologies employées par les différents auteurs et reconnaît qu'il reste beaucoup à faire pour approfondir l'étude du complexe de *P. machaon*, tout en maintenant qu'une approche plus holistique est nécessaire pour mieux comprendre les dynamiques multidimensionnelles qui ont façonné la biogéographie de la région de la Méditerranée centrale.

Key words: Island biogeography — European butterfly fauna — Central Mediterranean area — Dispersal — Sympatry — Identification methods.

Cassar L-F.: Institute of Earth Systems, University of Malta – Msida, MSD 2080, Malta. louis.f.cassar@um.edu.mt

DOI: 10.6084/m9.figshare.22722889

Introduction

Papilio machaon Linnaeus, 1758, is an iconic species and one of the best-known members of the family Papilionidae. In terms of habitat, it is highly versatile, with a presence across two Biogeographical Regions – Palaearctic and Nearctic (including four continents – Europe, Asia, Africa, and North America) and occurring in suitable biotopes from sea-level to ≈5000 m. As a result, the *machaon*-complex has been the focus of considerable research and much has been published in both generalist and taxon-specific contributions (Oberthür 1879; Eller 1936; Seyer 1974, 1976; Higgins & Riley 1978; Clarke & Larsen 1986; Sperling 1990). In more recent times, various studies involving DNA analysis have been carried out on taxa belonging to this complex, including those that occur within the Mediterranean Basin (Sperling 1993; Sperling & Harrison 1994; Pellecchia *et al.* 2002; Vodā *et al.* 2016; Dupuis & Sperling 2020; Domagala & Lis 2022), where a number of distinct subspecies and other related taxa occur (Oberthür 1915; Tennent 1996; Tolman & Lewington 1998; Tarrier & Delacre 2008; Tshikolovets 2011). One particular taxon, which has drawn a significant attention for sharing similar morphologies is *Papilio saharae* Oberthür, 1879. This taxon has been the subject of much debate and, to some extent, also controversy.

Key issues of *P. saharae* taxon delineation history and distribution

When the taxon was described, Oberthür (1879) initially treated it as a variety of *Papilio machaon* Linnaeus, 1758 — [Original combination: *Papilo machaon* var. *saharae* Oberthür 1879, Type Locality: Laghouat (Algeria)]. Less than a decade later, he described *P. machaon hospitonoides* from a larva (Oberthür, 1888), which transpired to be that of *P. saharae* (Pittaway *et al.* 1994). While a number of individuals have treated the taxon as a subspecies, or lower, of *Papilio machaon* Linnaeus, 1758 (Seitz 1908; Turati 1924; Seyer 1986; Pellecchia *et al.* 2002), others supported the view that it was a distinct species (Pittaway 1985; Larsen 1990; Pierron 1990; Pittaway *et al.* 1994; Tennent 1996; Tolman & Lewington 1998; Tarrier & Delacre 2008; Tshikolovets 2011; Leraut 2016). Until evidence to the contrary demonstrates otherwise, the present author also subscribes to this latter viewpoint (Cassar 2018; Cassar & Catania 2022; Cassar *et al.* 2023). The species concept of *P. saharae* is grounded in evidence based on both morphology and ecology, namely, (i) the number of discernibly disparate morphological characters of all four phases of metamorphosis (Higgins & Riley 1978; Pittaway

1985; Larsen 1990; Pierron 1990; Pittaway *et al.* 1994; Tennent 1996; Tolman & Lewington 1998; Moonen 2012), and (ii) the distinctly different habitats and biotopes that the two taxa are generally known to frequent (Larsen 1983, 1990; Clarke & Larsen 1986), in part dictated by altitude (Fig. 1). Some exceptions to this latter observation are known, notably but not exclusively from the south-eastern Tunisian sahel (Pierron 1990; Cassar 2018), where Clarke & Sheppard (1956) and Larsen (1990) noted evidence of "interspecific sterility" in the Maghreb. *P. saharae* is also known from coastal localities in Libya, at Barca, Benghazi and Tripoli (Clarke & Sheppard 1956; Seyer 1974), and from locations close to the littoral in Egypt, at El Salloum (Larsen 1990) and Marsa (Gilbert & Zalat 2007). While the degree to which it maintains a sympatric presence with *P. machaon* in Libya is not altogether clear (although plausible), Gilbert & Zalat (2007) quoting Larsen, state that both taxa may occur in the Sinai. In such a case, it would presumably be *P. machaon syriacus* as opposed to *P. machaon mauretanica* further west. The topic of natural zones of contact across the Maghreb and the eastern Mediterranean, including the Levant, and resultant interbreeding and hybridization is treated in quite some detail by Benyamini & John (2020). In the context of hybridization, also refer to Cassar *et al.* (2023), in which *Papilio saharae aferpilaggi* Cassar, Catania & Cotton 2023 was described from the central Mediterranean island of Lampedusa.

In 2012, a record of *P. saharae* came to light when museum specimens (at the time at the Zoological Museum, Amsterdam — ZMA) were being curated (Moonen 2012). The specimen in question, a male, was taken in Lentini in Sicily, by H. van Oorschot, in September of 1978. Consequently, Leraut (2016) claimed to have discovered several specimens of *P. saharae* also taken in Sicily, in the collections of the Muséum National d'Histoire Naturelle in Paris. Patrick Leraut provides no details on the specimens' field data nor on the morphological characters used and/or methodology employed to determine them. He also proposed that *P. machaon melitensis*, the taxon that occurs exclusively in Malta, be referred to as *P. saharae melitensis* Eller, 1936. The author apparently based his assessment on photographed material from the Internet (Rennwald 2021); however, as in the case of the Paris Museum specimens, he offered no scientific basis for this assertion. Coutsis *et al.* (2018) reacted to Moonen's (2012) record and Leraut's findings (2016), rejecting the notion of any presence of *P. saharae* in Europe. However, their conclusions were based on what appears to be a rather small sample size (even if the precise number of voucher specimens examined is not divulged). In an updated checklist of European butterflies, Wiemers *et al.* (2018) omitted any mention of *P. saharae*, the reason for which was undisclosed.

In the same year, Cassar (2018) reported a specimen from Giarratana in Sicily with a number of morphological characters akin to those of *P. saharae*; regrettably, an examination of the harpe (Fig. 2) was not an option, given it was a female specimen. Intriguingly, both Giarratana and Lentini lie on the Hyblean plateau, that is, the south-eastern portion of Sicily that effectively forms part of the emergent segments of the Pelagian Block (= foreland margin of the African plate boundary). Moreover, although the environment of these localities is generally semi-arid, it tends to become significantly more arid in areas of exposed terrain with shallow soils, particularly during the dry season (Cassar 2018).

Connectivity for dispersal

Island environments continue to provide an opportunity for biogeographical research since insularity is often a key driver in defining the biotic structure of island communities (Cassar & Pisani 2021). Insular systems can also provide some rather useful insights into natural processes, distribution patterns, and dispersal dynamics (Quammen 1996), particularly in relation to habitat fragmentation (Drake *et al.* 2002). Evolutionary development and subsequent speciation are typically influenced by a population's capacity to adapt to unfamiliar environmental conditions, coupled with sustained isolation from the species' centre of origin (Lomolino 2000). The biogeographical importance of the central Mediterranean area, comprising the marine causeway between northern Africa and southern Europe (specifically the Sicily Channel between the Siculo-Tunisian Sill and the eastward area encompassing the Pelagian Block), cannot be overstated.

A complex combination of geo-tectonics and climate-induced fluctuations in eustatic sea-levels during the late Miocene (Hsü 1983; Krijgsman *et al.* 1999; Gargani & Rigollet 2007) and later, during the Pleistocene epoch, provided the mechanism for dispersal of terrestrial biota through ecological corridors that formed intermittently during episodes of marine regressions (Massa 1982; Hunt & Schembri 1999; Cassar *et al.* 2007; Cassar & Pisani 2021). It is within the framework of such dynamic complexity that the biogeography of species, including that of *P. saharae*, needs careful consideration; most certainly, it should not be consigned to a 'polar interrogative' yes/no question, rendering what ought to be an objective scientific investigation, a simplistic box-ticking exercise. This is the key issue that the present contribution shall in part endeavour to address.

Aims

This paper is not intended to address the vexed question of whether *P. saharae* is present in Sicily or, if it indeed it is, how and when it reached the Mediterranean's largest island; nor does it set out to address its merited taxonomic rank. Rather it aims to revisit and discuss the respective methodologies employed by Moonen (2012), Leraut (2016) and Coutsis *et al.* (2018), while acknowledging that there remains scope to investigate the biogeography of the *P. machaon*-complex in the central Mediterranean area (including the north African mainland) taxonomically, through both morphometrics and molecular analysis.

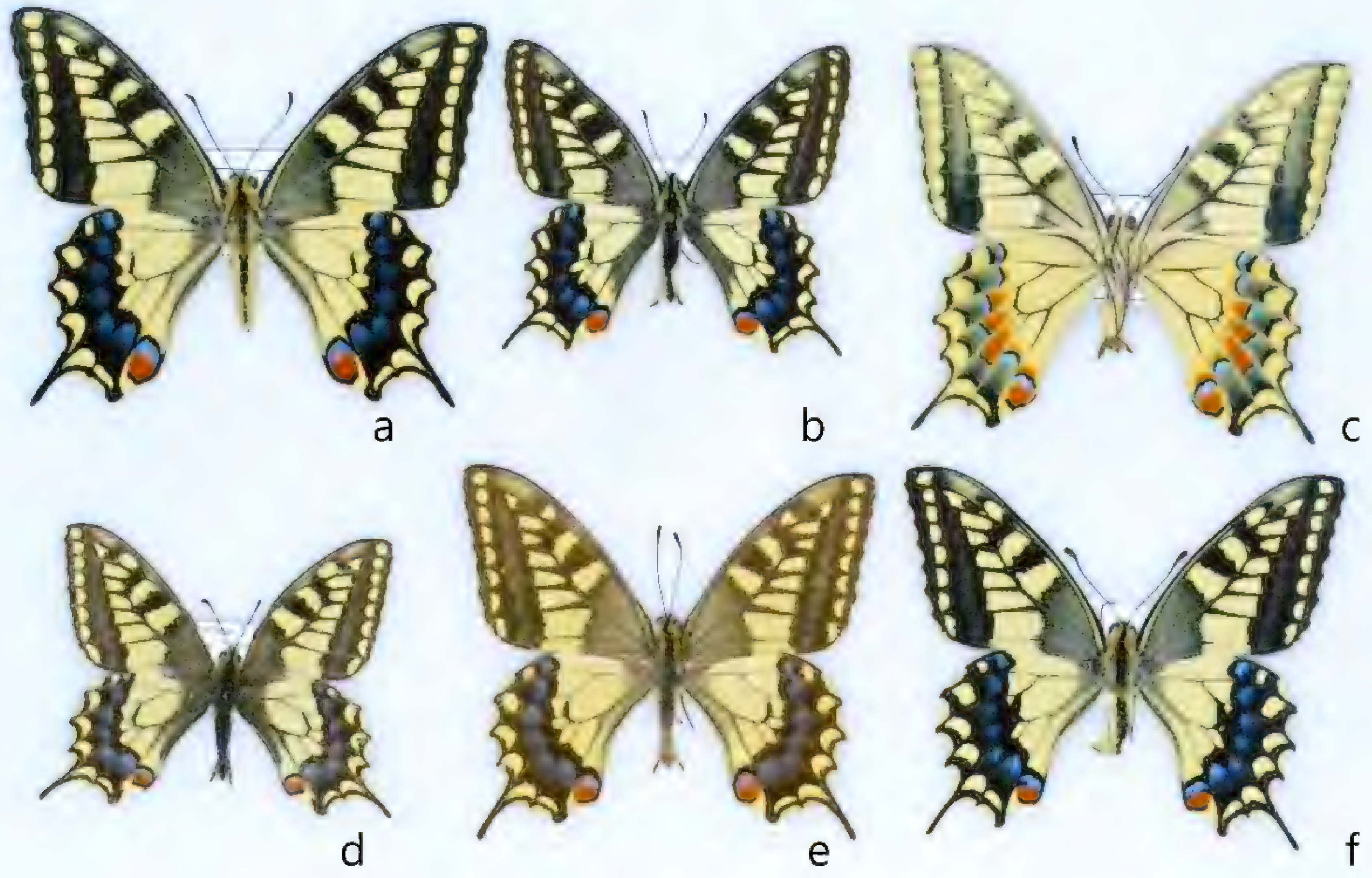


Fig. 1. Upper row: a, *Papilio machaon melitensis*, MALTA, *loc.* Kuncizzjoni, 190 m, ♂ 15.ix.2021 (Coll. AC); b, *loc.* Zebbug, 60 m, ♂ 13.v.2019 (Coll. LFC); d, *loc.* Kuncizzjoni, 190 m, ♂ 15.ix.2021 (Coll. AC). This taxon, as is common with a number of other related subspecies, demonstrates significant size disparity among adults, with variance not exclusively a function of seasonality or concentration of available larval food sources. The dimensions of adult individuals of mutual broods (inclusive of bred siblings) are also known to vary appreciably.

Lower row: d, *Papilio saharae saharae*, MOROCCO, *loc.* Tizi-Tazouguart, 1150 m, ♂ 19.iv.2018 (Coll. LFC); e, *Papilio machaon sphyrus*, ITALY, Sicily, *loc.* Adrano, Mt. Etna, 560 m, ♂ 22.vii.1979 (Coll. LFC); f, *loc.* Il Pagliaio delle Madonie, 1036 m, ♂ 14.vi.2019 (Coll. AC). [Deposited in the collections of Louis-F. Cassar or A. Catania]. © Aldo Catania.

Discussion

The diversity of habitats within which the taxon occurs is well documented. *P. saharae* is not a species that is restricted exclusively to eremic environments as is commonly assumed. The nominotypical *P. saharae saharae*, the range of which extends from Morocco to the Red Sea and beyond into the northern Hejaz, is known from hyper-arid zones on the northern fringes of the Sahara Desert, as well as from arid steppe and semi-arid plains closer to the Mediterranean coast, where zones of contact with *P. machaon* are known to occur (Clarke & Sheppard 1956; Seyer 1974; Larsen, 1990; Pierron 1990; Gilbert & Zalat 2007; Cassar 2018; Benyamini & John 2020). *P. saharae rathjensi*, the subspecies from Yemen and the Asir region in Saudi Arabia, is typically found around mesic habitats within rocky uplands and montane zones (Larsen 1983, 1984, 1990; Pittaway 1985; Meerman & Boomsma 1986).

Although preferences relating to habitat and biotope-types as well as flight period have often been alluded to as distinguishing features to separate the two taxa (Larsen 1990; Pittaway *et al*. 1994; Tennent 1996; Tolman & Lewington 1998; Moonen 2012), various records have demonstrated instances which digress from the typical 'dry' for *P. saharae* and 'temperate' for *P. machaon* composition, especially where the two taxa occur sympatrically and where their respective favoured climatic zones tend to grade into one another without clearcut delineation (Larsen 1990; Pierron 1990; Gilbert & Zalat 2007; Cassar 2018; Cassar & Catania 2022). It also seems that both *P. machaon* and *P. saharae* can produce a number of generations across seasons when conditions are suitable, even if it has been noted that *P. saharae* broods are quite dependent on annual patterns of precipitation (Pittaway *et al*. 1994). Given such a scenario, might there be instances where *P. saharae* is exploiting *ecological refugia* in enclaves supporting environmentally suitable, albeit fragmented, biotopes, but also dispersing onto adjacent, more temperate zones? Recent field research within the central Mediterranean area has revealed interesting new insights on the adaptation of *P. saharae* to semi-arid environments (Cassar & Catania 2022; Cassar, Catania & Cotton 2023).

The critique that follows identifies some insufficiencies in the approaches employed to assess the presence of *P. saharae* in southern Europe. Perhaps one of the first errors of judgement occurred when Moonen (2012) did not broaden his investigation to include an examination of the genitalia of the male specimen encountered during

Fig. 2. Harpe; a, *Papilio saharae saharae*; b, *P. machaon sphyrus*; c, *P. machaon melitensis*. © Aldo Catania.

the curation exercise at the ZMA. Had he not fallen short of counting the teeth on the harpe, one of the more critical characteristics for defining *P. saharae*, the identity of the specimen would have been settled beyond question and the issue of distribution conclusively laid to rest. Of course, such an omission does not diminish the likelihood of the taxon's presence in Sicily but may give rise to doubts amongst those sceptical of such occurrence. A few years following the Moonen publication, Leraut (2016) made a somewhat extraordinary claim of having come across a number of Sicilian specimens in the collections of the museum in Paris that, according to the author, were erroneously determined as *P. machaon* but which he identified as *P. saharae*. Unfortunately, he provided no specifics, either of locality or biometric data, nor of his approach to determining the said specimens. Had such data and method been included, Leraut's findings could potentially be considered more reliable. Perhaps even more remarkable was his declaration that *P. machaon melitensis*, the subspecies present on the Maltese Islands, should be referred to as *P. saharae melitensis* Eller, 1936. Apparently, Leraut based his determination on photographed pinned butterfly specimens on the Internet (Rennwald 2021), which may or may not have had a scale bar or other taxa of the *machaon*-complex for comparative purposes. It may also be pertinent to add that the Malta taxon was molecularly analysed in the past (Vodă *et al*. 2016) and nothing unpredicted was reported. Coutsis *et al*. (2018), who published some interesting lab-work results involving artificial hybridisation between *P. machaon* and *P. saharae*, rejected Moonen's record and all of Leraut's claims and suggestions. The issue with the view held by Coutsis *et al*. (2018) is that the authors based their decision on the examination of a handful of specimens from Sicily and Malta (the precise number of which was never divulged) which they compared with *P. saharae* from the Negev desert in Israel. Perhaps, had the museum specimens referred to by Moonen (2012) and Leraut (2016) been re-examined, the issue would have been resolved.

More significantly, the foregoing highlights the fact that related investigations need to be broadened, to incorporate a thorough understanding of the biogeography of the taxa in question, particularly with reference to the rather complex geo-tectonic and climate-induced eustatic sea-level fluctuations that had a profound influence on dispersal patterns and biotic make-up within the central Mediterranean area. In the absence of such a holistic and integrated approach, any conclusions, i.e., that *P. saharae* should be excluded from the fauna of Sicily, are highly debatable, if not distinctly unconvincing. At this juncture, it may be apposite to add that in May of 2018, the present author took a female specimen at Giarratana in Sicily (not too distant from Lentini, where the Moonen specimen was taken), which had a number of discernible morphological characters common to *P. saharae*, notably, 31 antennal segments, a compressed vannal fold with a small red ovoid ocellus and an evident smattering of yellow scales over the dark markings of the forewing basal and postbasal areas and the hindwing basal and inner margin regions (Cassar 2018). The contribution discusses the potential of a relict population of *P. saharae*, as well as various scenarios concerning dispersal, sink and source dynamics, past and present environmental conditions, and the multifarious processes that influenced biotic make-up as a consequence of Quaternary Period climate-induced changes in some detail.

Conclusions

Opportunities for dispersal are highly likely to have existed in the past, particularly during Quaternary lowstands, while *P. saharae*'s ability to thrive in less arid environments has been demonstrated on numerous occasions by various authors (cited above). So why disavow the notion of the species' presence in southern Europe? Notwithstanding the fact that islands tend to make poor targets (compared to continental landmasses) for immigrant organisms, the extensive length of the Sicilian coastline, coupled by the significantly shorter distance across the Siculo-Tunisian strait during the Quaternary Period, it is certainly not implausible that non-migrant species such as *P. saharae* made landfall and successfully adapted to Sicily's semi-arid environment.

In summary, the key takeaway of the message presented above is the value of a holistic and sound methodological design, and the questions it raises for future research on the distribution and status of *Papilio saharae* in the central Mediterranean area. An integrated approach towards understanding the biogeography of the species can not only shed light on phylogenetic relationships with other taxa, but also provide vital evidence of past environments and climates, including

landform and associated dynamics, in this case, of the central Mediterranean area. Such knowledge, coupled with a thorough understanding of the taxon's distribution patterns and its capacity to adapt to different habitats, is crucial to any effort to apply conservation measures that may ensure the species' long-term survival. Finally, the present author would like to emphasize that the intention of this contribution is not that of censorship and that any perceived criticism is intended to objectively improve current knowledge.

Acknowledgements

I would like to express my sincere thanks to Elisabeth Conrad and Adam Cotton for their insightful comments and useful feedback, which most certainly led to an improved manuscript. I am also grateful to Aldo Catania for providing some of the specimens that appear in the figures and for taking the photographs.

References

Benyamini D. & John E. 2020. *Butterflies of the Levant and nearby areas*. Vol. II: *Papilionidae, Pieridae & Hesperiidae*. 4D MicroRobotics Publications Ltd. 208 pp.

Cassar L.-F. 2018. *Papilio saharae* Oberthür, 1879 (Lepidoptera Papilionidae) on the Hyblean Plateau, Sicily: Case of a relict population due to climate-driven phenomena? — *Naturalista siciliano* **42**(1): 21–29.

Cassar L.-F. & Pisani C.M. 2021. A follow-up cycle of observations on the endemic *Pamphagus ortolanii* (Acridoidea Pamphagidae). — *Naturalista siciliano* **45**(1–2): 237–246.

Cassar L.-F. & Catania A. 2022. Preliminary findings on the presence of a taxon with morphological traits of *Papilio saharae* Oberthür, 1879 in Lampedusa (Italy) (Lepidoptera: Papilionidae). — *SHILAP Revista de lepidopterología* **50**(198): 303–312.

Cassar L.-F., Catania A. & Cotton A. M. 2023. A new subspecies of *Papilio saharae* Oberthür, 1879 (Lepidoptera: Papilionidae) from Lampedusa, Italy. — *Zootaxa* **5231**(1): 065–078.

Clarke C. A. & Larsen T. B. 1986. Speciation problems in the *Papilio machaon* group of butterflies. — *Systematic Entomology* **11**: 175–181.

Coutsis J. G., Anastassíu H. & Benyamini D. 2018. About the recently published records of *Papilio saharae* from Sicily and Malta (Lepidoptera: Papilionidae). — *Phegea* **46**(4): 132–136.

Domagala P. A. & Lis J. A. 2022. One species, hundreds of subspecies? New insight into the intraspecific classification of the Old World swallowtail (*Papilio machaon* Linnaeus, 1758) based on two mitochondrial DNA markers. — *Insects* **13:** 752.

Drake D. R., Mulder C. P. H., Towns D. R. & Daugherty C. H. 2002. The biology of insularity: an introduction. — *Journal of Biogeography, Special Issue: Insular Biotas* **29**(5/6): 563–569.

Dupuis J. R. & Sperling F. A. H. 2020. Phylogenomic test of mitochondrial clues to archaic ancestors in a group of hybridizing swallowtail butterflies. — *Molecular phylogenetics and evolution* **152**: 106921.

Gargani J. & Rigollet C. 2007. Mediterranean Sea level variations during the Messinian Salinity Crisis. — *Geophysical Research Letters* **34**(10): L10405.

Gilbert F. & Zalat S. 2007. *Butterflies of Egypt: Atlas, Red Data Listing, & Conservation*. Nature Conservation Sector, Egyptian Environmental Affairs Agency, 183 pp.

Higgins L. G. & Riley N. D. 1978. *Die Tagfalter Europas und Nordwestafrikas*. — Verlag Paul Parey, Hamburg, Berlin, 377 pp.+60 pl.

Hsü K.J. 1983. *The Mediterranean was a Desert*. — Princeton University Press, Princeton, New Jersey. 197 pp.

Hunt C. O. & Schembri P. J. 1999. Quaternary environments and biogeography of the Maltese Islands. — *In*: Mifsud A. & Savona Ventura C. (eds.), *Facets of Maltese prehistory*. — The Prehistoric Society of Malta, Malta, 41–75 pp.

Krijgsman W., Hilgen F.J., Raffi I., Sierro F.J. & Wilson D. S. 1999. Chronology, causes and progression of the Messinian salinity crisis. — *Nature* **400**(6745): 652–655.

Larsen T. B. 1984. The zoogeographical composition and distribution of Arabian butterflies (Lepidoptera; Rhopalocera). — *Journal of Biogeography* **11**: 119–158.

Larsen T. B. 1990. *The Butterflies of Egypt*. Apollo Books, American University Press, Cairo, 112 pp.+8 pl.

Leraut P. 2016. *Butterflies of Europe and neighbouring regions*. *N.A.P Ed*., Verrières-le-Buisson, 1113 pp.+ 655 pl.+ 6000 photos.

Lomolino M. V. 2000. A Call for a New Paradigm of Island Biogeography. — *Global Ecology and Biogeography* **9**(1): 1–6.

Massa B. 1982. Il gradiente faunistico nella penisola Italiana e nelle Isole. *Atti della Società Italiana di Scienze Naturali* e *del Museo Civico di Milano* **123**: 353–374.

Meerman J. & Boomsma T. 1986. The little-known swallowtail from northern Yemen, *Papilio saharae rathjensi* Warnecke 1932 — Field observations and breeding (Lepidoptera: Papilionidae). — *Entomological Journal* **96**(13): 177–182.

Moonen J. J. M. 2012. Notes on the *Papilio machaon* group (Lepidoptera: Papilionidae) from the Palaearctic Papilionidae collection of the Zoological Museum of Amsterdam. — *Entomological Reports* **72**(3): 184–186.

Oberthür C. 1879. Catalogue raissoné des Papilionidae de la collection de Ch. Oberthür. — *Études d'Entomologie* **4**: 19–102, 107–117, pls. I–VI. https://www.biodiversitylibrary.org/page/10180732

Oberthür C. 1888. Faunes Entomologiques. Descriptions d'insectes nouveaux ou peu cunnus. III. Lépidoptères d'Europe et d'Algérie. — *Études d'Entomologie* **12**: 21–46. https://www.biodiversitylibrary.org/page/10426455

Oberthür C. 1915. Faune des Lépidoptères de la Barbarie. — *Études de Lépidoptérologie comparée* **10**: 7–459, pl. 276–297, 301, 302, 306–309. https://www.biodiversitylibrary.org/page/9648659

Pellecchia M., Marini M. & Scali V. 2002. Diversità mitocondriale nel *Papilio machaon* species complex (Papilionidae): evidenze dai geni CO I e NADH 4. — *Atti XIX Congresso Nazionale Italiano di Entomologia,* 131–134.

Pierron M. 1990. Contribution a la connaissance de la biologie de *Papilio machaon saharae* Obth. Differences avec *Papilio machaon machaon* L. et hybridations experimentales (Lep. Papilionidae). — *Alexanor* **16**(6): 331–340.

Pittaway A. R. 1985. Lepidoptera Rhopalocera from western Saudi Arabia. — *Fauna of Saudi Arabia* **7**: 172–197.

Pittaway A. R., Larsen T. B., Clarke C. A., Smith C. R., Crnjar R. & Clarke F. M. M. 1994. *Papilio saharae* Oberthür, 1879, specifically distinct from *Papilio machaon* Linnaeus, 1758 (Lepidoptera: Papilionidae). — *Entomologist's Gazette* **45**(4): 223–249.

Quammen D. 1996. *The Song of the Dodo: Island Biogeography in an Age of Extinctions*. Scribner, New York, 702 pp.

Rennwald E. 2021. Aid for determining the butterfly species found in Europe. *Papilio saharae* Oberthür, 1879. Version 17. Last modified by Jürgen Rodeland on November 14, 2022. https://lepiforum.org/*Papilio_saharae* (accessed 22 December 2022).

Seitz A. 1907–1909. Grossschmetterlinge der Erde, Vol. 1, Die palaearktischen Tagfalter. — A. Kernen Verlag, Stuttgart. 379 pp. + 89 pls + 3470 figs. https://www.biodiversitylibrary.org/page/10122597

Seyer H. 1974. Versuch einer Revision der *Papilio machaon* subspezies in der westlichen Paläarktis. — *Mitteilungen der Entomologischen Gesellschaft Basel* **24**: 64–90, 93–117.

Seyer H. 1986. Zum taxonomischen Status von *Papilio machaon saharae*. — *Entomologische Zeitschrift* **96/18**: 270.

Sperling F. A. H. 1990. Natural hybrids of *Papilio* (Insecta: Lepidoptera): poor taxonomy or interesting evolutionary problem? — *Canadian Journal of Zoology* **68**(8): 1790–1799.

Sperling F. A. H. 1993. Mitochondrial DNA phylogeny of the *Papilio machaon* species group (Lepidoptera: Papilionidae). — *Memoirs of the Entomological Society of Canada* **125**(S165): 233–242.

Sperling F. A. H. & Harrison R. G. 1994. Mitochondrial DNA variation within and between species of the *Papilio machaon* group of swallowtail butterflies. — *Evolution* **48**(2): 408–422.

Tarrier M. R. & Delacre J. 2008. *Les papillons de jour du Maroc. Guide d'identification et de bioindication*. — Muséum national d'Histoire naturelle, Paris; *Biotope*, Mèze, 480 pp.

Tennent J. 1996. *The Butterflies of Morocco, Algeria and Tunisia*. — Gem Publishing Co., xxxvi + 217 pp.

Tolman T. & Lewington R. 1998. *Die Tagfalter Europas und Nordwestafrikas, übersetzt von M. Nuß*, Franckh-Kosmos. — Verlags-GmbH & Co., Stuttgart, 319 pp.

Tshikolovets V. V. 2011. *Butterflies of Europe & the Mediterranean area*. — Tshikolovets Publications, Kyiv, 544 pp.

Turati E. 1924. Spedizione Lepidopterologica in Cirenaica 1921–22. — *Atti della Società Italiana di Scienze Naturali* **63**: 21–129.

Vodă R., Dapporto L., Dincă V., Shreeve T. G., Khaldi, M., Barech G., Rebbas K., Sammut P., Scalercio S., Hebert P. D. & Vila R. 2016. Historical and contemporary factors generate unique butterfly communities on islands. — *Scientific Reports* **6**: 1–11.

Wiemers M., Balletto E., Dincã V., Fric Z. F., Lamas G., Lukhtanov V., Munguira M. L., Swaay C. A. M. van, Vila R., Vliegenthart A., Wahlberg N. & Verovnik R. 2018. An updated checklist of the European Butterflies (Lepidoptera, Papilionoidea). — *ZooKeys* **811**: 9–45. https://zookeys.pensoft.net/article/28712/

Melitaea telona complex of species (Lepidoptera: Nymphalidae: Nymphalinae: Melitaeini) in the Levant and description of a new species

Dubi Benyamini

Abstract. The representatives of the *Melitaea telona* complex of species (Nymphalidae) in the Levant region are reviewed, certain genitalia traits are analyzed and discussed. The lectotype of *Melitaea phoebe dorae* Graves, 1925, is designated, resulting in *M. phoebe telona* Fruhstorfer, 1908 as a senior species-group name. In our analysis three species are involved: (1) *Melitaea klili* Benyamini, 2021 multi-brooded species, the "ancestor" of the group (with genitalia type A); (2) *Melitaea telona* Fruhstorfer, 1908 single-brooded east Mediterranean species (with genitalia types A and B), and (3) *Melitaea tzinensis* **n. sp.**, which originates in the southern and eastern deserts and desiccated biotopes in the Levant (with genitalia type B). *Melitaea phoebe telona* Fruhstorfer, 1908 is synonymized with *Melitaea phoebe dorae* Graves 1925, **n. syn.** I present the results regarding the male genitalia trait analysis and remark on the evolutionary history of these Levant *M. telona* spp. reflecting the climate change in the east Mediterranean region since the last glacial period.

Samenvatting. De vertegenwoordigers van het *Melitaea telona*-soortencomplex (Nymphalidae) in de Levant worden besproken en bepaalde kenmerken van de genitaliën worden geanalyseerd en besproken. Het lectotype van *Melitaea phoebe dorae* Graves, 1925, wordt aangewezen, met *M. phoebe telona* Fruhstorfer, 1908 als senior soort-groep naam. In onze analyse gaat het om drie soorten: (1) *Melitaea klili* Benyamini, 2021, een soort met meerdere generaties per jaar, de "stamvader" van de groep (met genitaliën type A); (2) *Melitaea telona* Fruhstorfer, 1908, een oost-mediterane soort met slechts één generatie (met genitaliën type A en B) en (3) *Melitaea tzinensis* **n. sp.** die afkomstig is uit de zuidelijke en oostelijke woestijnen en verdroogde biotopen in de Levant (met genitaliën type B). *Melitaea phoebe telona* Fruhstorfer, 1908 is gesynonymiseerd met *Melitaea phoebe dorae* Graves, 1925, **n. syn**. Ik presenteer de resultaten betreffende de analyse van de kenmerken van de mannelijke genitaliën en maak opmerkingen over de evolutionaire geschiedenis van deze *M. telona* spp. in de Levant, die de klimaatverandering in het oostelijke Middellandse-Zeegebied sinds de laatste ijstijd weerspiegelt.

Résumé. Les représentants du complexe d'espèces *Melitaea telona* (Nymphalidae) dans la région du Levant sont passés en revue, certains caractères génitaux sont analysés et discutés. Le lectotype de *Melitaea phoebe dorae* Graves, 1925, est désigné, avec comme résultante *M. phoebe telona* Fruhstorfer, 1908 comme nom supérieur. Dans notre analyse, trois espèces sont impliquées: (1) *Melitaea klili* Benyamini, 2021 espèce multi-brodée, "l'ancêtre" du groupe (avec des genitalia de type A); (2) *Melitaea telona* Fruhstorfer, 1908 espèce méditerranéenne orientale à un seul code (avec des genitalia de types A et B) et (3) *Melitaea tzinensis* **n. sp.** qui est originaire des déserts du sud et de l'est et des biotopes desséchés du Levant (avec des genitalia de type B). *Melitaea phoebe telona* Fruhstorfer, 1908 est synonymisé avec *Melitaea phoebe dorae* Graves, 1925, **n. syn**. Je présente les résultats concernant l'analyse des caractéristiques des genitalia mâles et donne des remarques sur l'histoire évolutive de ces *M. telona* spp. du Levant, reflétant le changement climatique dans la région de la Méditerranée orientale depuis la dernière période glaciaire.

Key words: *Melitaea telona* — *Melitaea klili* — Middle East — New species — Climate change — Lectotype — Nymphalidae.

Benyamini D.: Levona 91, 7194700 Beit-Arye, Israel. dubi_ben@netvision.net.il

DOI: 10.6084/m9.figshare.22722907

Introduction

The Levant (eastern Mediterranean) life zone is the only place on the globe where two main zoogeographical regions, the Palaearctic and Afrotropical with their southern and northern ecotones (respectively), meet in a unique crossroads, where three additional sub-regions i.e. Irano Turanian eastern steppes, Saharo-Sindian eremic zone and Sudanian Rift-Valley tropical penetrating zone, support the evolutionary history of the *Melitaea telona* species complex consisting of three species *Meliteae klili* Benyamini, 2021, *M. telona* Fruhstorfer, 1908, and *M. tzinensis* **sp. n**. The biogeography of the complex in the Levant following the dramatic Paleoclimate changes since the last glacial post-Pleistocene (Torfstein & Enzel 2017; Goldreich 1998; Frumkin & Comay 2021; Ludwig & Hochman 2021) is explained in this paper. In his cornerstone publication on the "Rhopalocera and Grypocera of Palestine and Transjordania", Philip Perceval Graves (1856–1953), in the pages of the journal *Transactions of the Royal Entomological Society of London*, summarized the butterfly knowledge gathered in Palestine from the late 19th century, before, during and post WWI, mostly by British officers on tour of duty (Graves 1925). Among his 79 listed taxa there were four "nova" sspp. and four additional species that he refrained from naming. In this paper, I revise the nominal taxon which P.P. Graves described as *Melitaea phoebe dorae* and present the knowledge of our group on the *Melitaea telona* species complex (see Benyamini 2021). Furthermore, I describe below a new species. No less than 83 male genitalia from 18 localities from south Jordan's desert to the Lebanese mountains 520 km away, from specimens spanning 115 years from 1907 (Jerusalem, type locality of *M. telona*) until spring 2022 (Nahal Shezor, type locality of *M. klili*), were dissected and their valval distal process (VDP) documented and measured (Fig. 1a). The larval hostplants of all the taxa involved are also given.

Abbreviations:

BMNH = British Museum of Natural History, London (now Natural History Museum, London (NHMUK)); DB = Dubi Benyamini; L = larva; LHP = larval host plant; TL = type locality; VDP = valval distal process; WL = wing length (measured from forewing base to apex).

Fig. 1a. VDP types A and B of 83 *Melitaea telona* complex specimens in 18 biotopes of Levant.

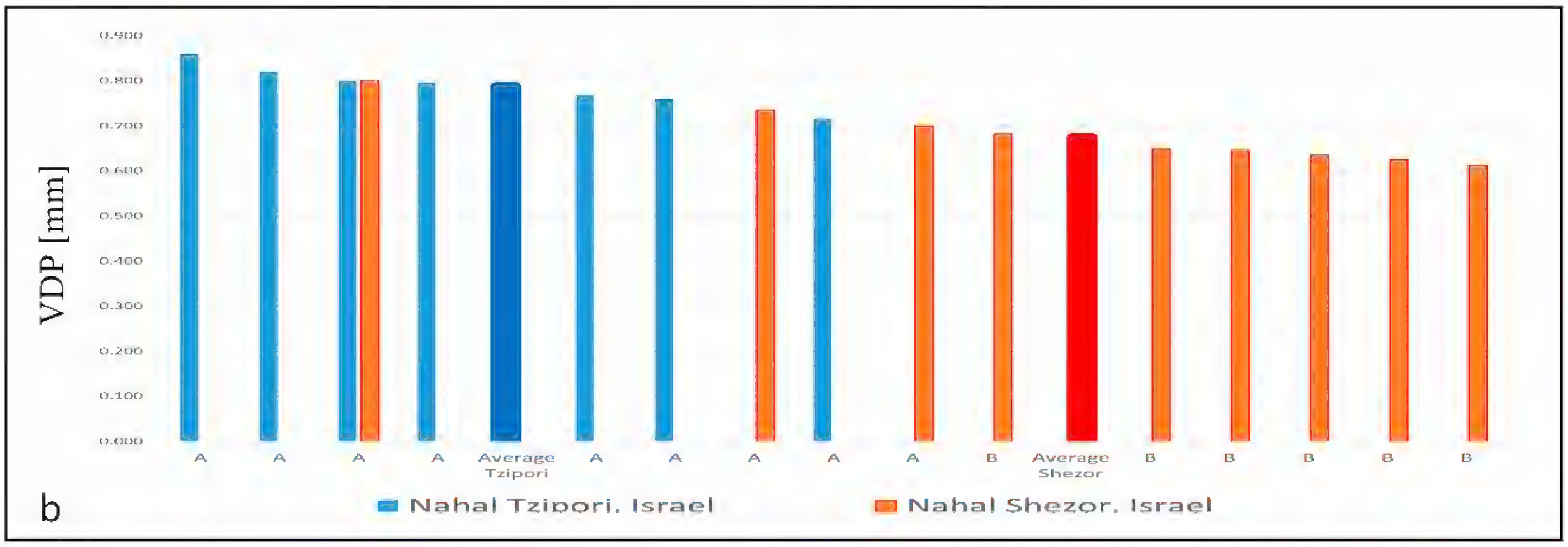


Fig. 1b. VDP length (in mm) and type A or B of *Melitaea klili* in its two western Galilee localities: Nabal Tzipori – blue type A (average 0.788 mm) and Nahal Shezor – orange types A and B (average 0.676 mm).

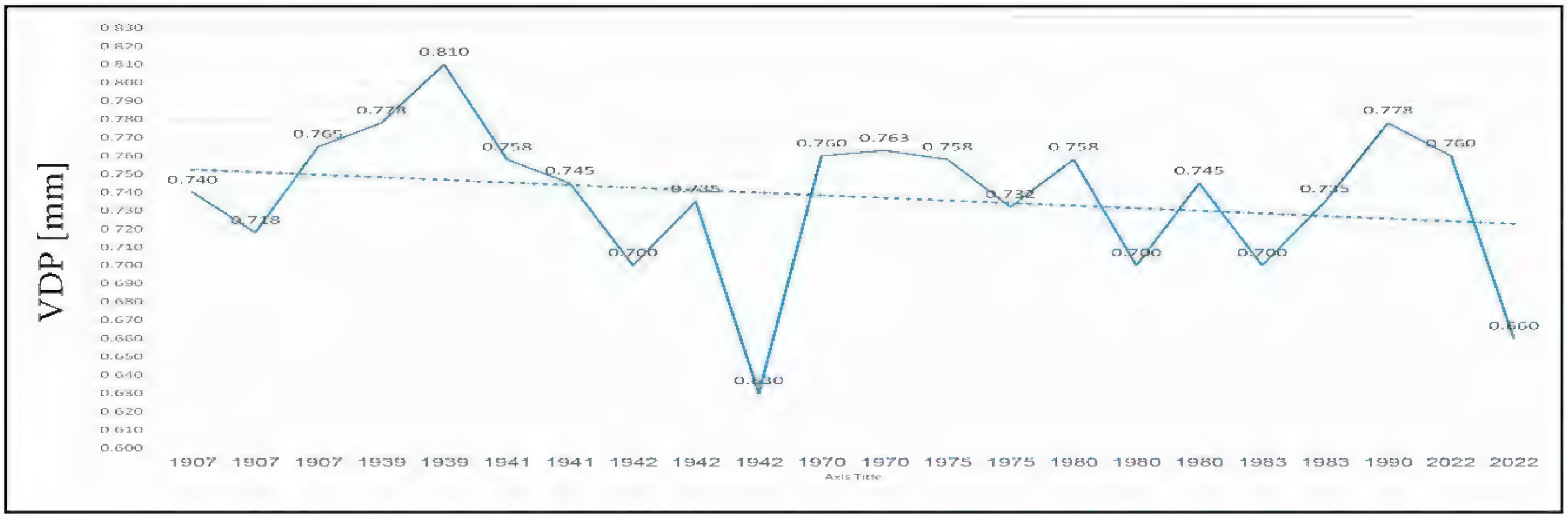


Fig. 1c. VDP length (in mm of 22 *Melitaea telona* specimens collected in Jerusalem between 1907 and 1922 with average decline values.

The problematic description of “*Melitaea phoebe* subsp. *dorae*”

A bright form with reduced black markings, “Rather small race, larger than Beirut *telona*” of “*Melitaea phoebe telona*” that were collected in Petra, Edom, central–southern Jordan, attracted P. P. Graves’ attention and he dedicated considerable space to examining 13 males and three females of this “race” and compared it with 15 *M. phoebe telona* Fruhstorfer, 1908 males from Transjordan (northern areas), Mar Saba (Judean Desert in Israel), Judaea (Israel) and Beirut to six males of *M. phoebe ogygia* Fruhstorfer, 1908 from Athens and one male *Melitaea phoebe* ([Denis & Schiffermüller], 1775) “from the Engadine (Switzerland) in the British Museum for comparison”. To do this tiresome comparison he divided the upper surface of the forewing into three sections, and the hindwing into five sections; each section received an index figure of its “nigrescence” between 1 (no black markings) and 10 (“entirely suffused black”). The results of this interesting comparison are presented in one of Graves’ paper (1925: 105). The results show clearly the “nigrescence” increase from the bright desert “race” *dorae* (average index number 21.96) through *telona* (29.89), to the darker Greek *M. phoebe ogygia* (36.30) and the darkest: Swiss *M. phoebe* (50). While the results indicate brighter specimens in southern localities, which is normal because of its higher solar radiation, there are some annoying facts in Graves’ meticulous treatment:

- It seems that the Petra specimens that were collected by H. St. J. Philby in March 1922 and March 1923 are a local selected group not representing the whole Edom population where normal *M. telona* species is quite widespread i.e. records of collected *M. telona* specimens in Dana reserve (Edom) only 45 km northwards (leg. DB, coll. DB).
- Specimens without markings on the hindwings appear normally in all the Levant’s *M. telona* species complex populations in changing percentages. This includes bred specimens of *M. klili* from the Tzipori and Shezor biotopes where *M. phoebe dorae* or partial *M. phobae dorae* specimens with reduced “nigrescence” appear together with normal forms. These mixed forms may be the offspring from the same egg batch of one female (following DB breeding notes).
- P.P. Graves refrained from designating the holotype or “type” in his original description and the yellow round labels marking the Petra material as “co-types” were added later by the staff of the NHMUK (ex BMNH) (Fig. 4).

Designation of the lectotype for *Melitaea phoebe dorae* Graves, 1925

The specimen selected and designated here as lectotype by DB was listed by P.P. Graves amongst the studied material. It is a male specimen, set dorsally in perfect condition (no damage) with forewing costa length 19.2 mm, with two original labels: (1) “Trans Jordan, Petra, 26. iii.1929” and (2) “H. St. J. Philby” (both rectangular, white paper with black printed letters). There are two subsequent labels: “B. M. TYPE No. 8284” and “Photograph No. NHMUK 014172682”. We have added a white label with the printed letters: “*Melitaea phoebe dorae* Graves, 1925; designated by Dubi Benyamini, 2023”, and a red label with the printed letters: LECTOTYPE (Fig. 4). The lectotype specimen now objectively represents the nominal taxon *Melitaea phoebe dorae* Graves, 1925 and fixes its identity. The lectotype is deposited in the collection of NHM, London.

On the basis of wing pattern and geographical location of the type locality, I consider: ***Melitaea phoebe telona*** Fruhstorfer, 1908

= *Melitaea phoebe dorae* Graves, 1925, **new synonym.**

For details see the following considerations.

The *Melitaea telona* species group and their historic perspective

Melitaea klili Benyamini, 2021

Since about twenty thousand years ago, from the end of the last glacial period, when the climate was wetter and *Centaurea* LHPs flourished during longer springs, we had only *Melitaea klili* the “ancestor” – similar to the population of today’s Tzipori rivulet refuge (Fig. 5) where the *Melitaea “telona”* are multi-brooded and the VDP is mostly* the large type A (Fig. 1b). This taxon’s survivability during so many years is due to its unique genetics and epigenetics usually unknown in other papilionoids – their larvae at L3, L4 and L5 start long-term annual diapause whenever the food is in short supply; whilst in most other species the starving larvae die or, seldomly, pupate to produce dwarf adults. Their relict local populations testify that they could survive sudden hot and dry weather conditions during former inter-glaciation periods. The LHPs of *M. klili* in Shezor and Tzipori biotopes are large perennial pink-flowered *Centaurea iberica* var. *sepphoris* (Benyamini 2021) (Fig. 5).

Additional *M. klili* populations possibly exist further north of Israel along the Levant coast in wet biotopes:

(a) In Lebanon around Beirut where the existence of three annual broods was reported: “On the coast there are two further broods, one in June/July, another in August/September, but both are much less numerous than the first” (Larsen 1974: 123), as in the Israeli west Galilee populations.

(b) The Syrian Mediterranean coast near Latakia may have similar unexplored wet biotopes with *M. klili* multi-generation populations (Benyamini 2021: 190).

* The wider upstream Nahal Tzipori at Ka'abiyye-Tabbash-Hajajre narrows downstream at the “Tahanat HaNezirim” (the Monk’s Mill), where on both sides of the valley the adjacent mountain slopes are the home of single-brooded *M. telona*, hence the reason for having a mix of both species in *M. klili* type-locality and biotopes in western Galilee.

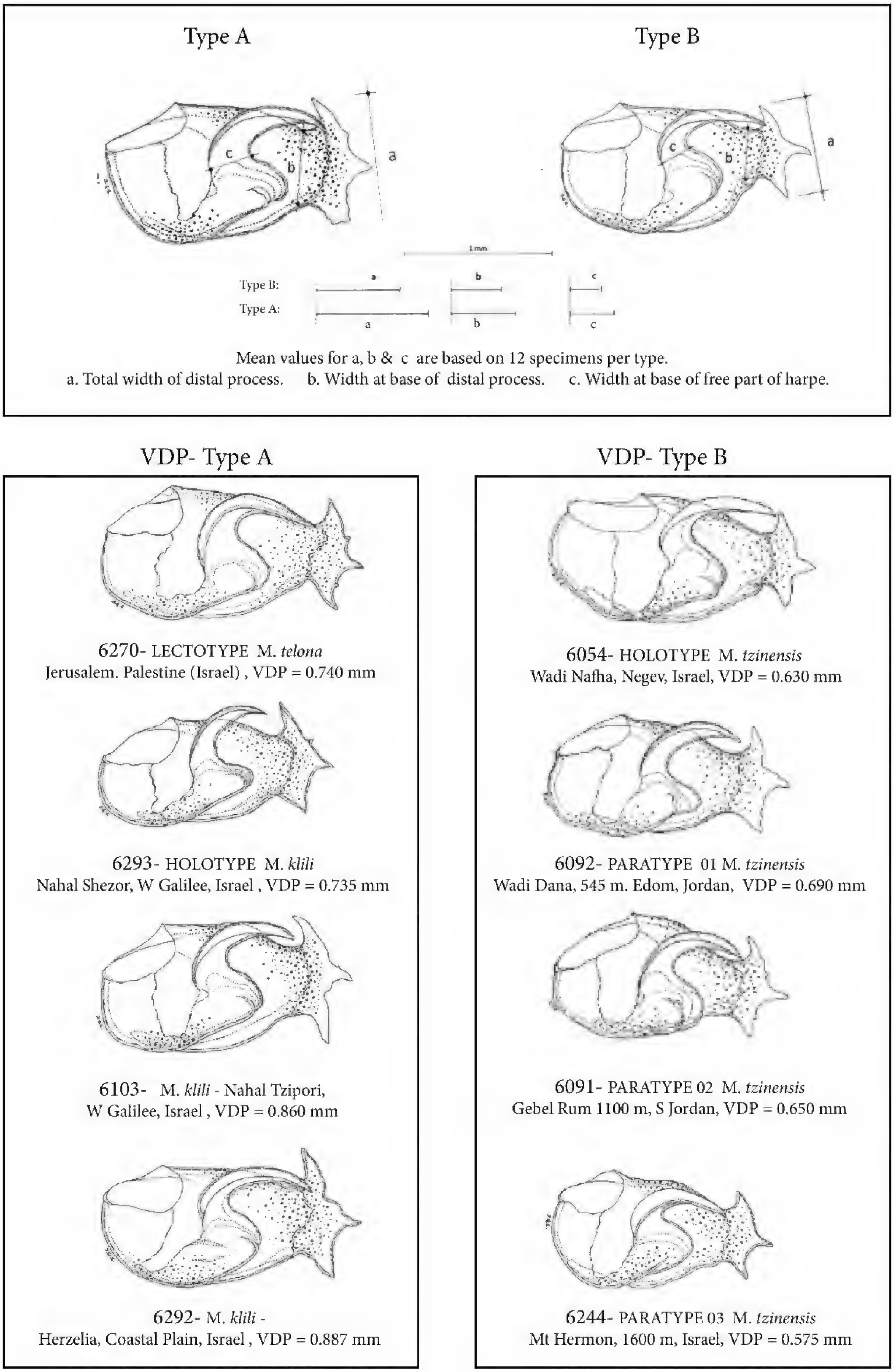


Fig. 2. Genitalia drawings of *Melitaea telona* Lectotype, *M. klili* Holotype, all *M. tzinensis* types + largest VDP type A and smallest VDP type B are drawn for comparison by John Coutsis. © John Coutsis.

Melitaea telona Fruhstorfer, 1908

When the long-term desiccation process (which is increasing at present) started and the LHP became in shorter supply, i.e. because of shorter springs, shorter flowering period and less available food, the number of annual broods decreased to one and *Melitaea telona* appeared in moderate VDP sizes; mostly type A lower values presented by the lectotype, paralectotypes and most specimens in the Levant and possibly southern Europe. The known *telona*'s LHPs in the Levant include Asteraceae: *Carduus argentatus* L., *Carthamus tenuis* (Boiss. & C.I.Blanche) Bornm., *Centaurea aegyptiaca* L., *C. crocodylium* L., *C. cyanoides* Berger, *C. eryngioides* Lam., *C. hyalolepis* Boiss., *C. iberica* Trevir. ex Spreng., *Crupina crupinastrum* (Moris) Vis., *Cynara syriaca* Boiss., *Notobasis syriaca* (L.) Cass., *Silybum marianum*, (L.) Gaertn.; Dipsaceae: *Scabiosa* sp.; Plantaginaceae: *Plantago* sp. (Benyamini 2021: 188). Additional *telona* broods in natural conditions are rare in its southern distribution limit.

In Israel: we know of only one specimen collected in Herzelia on 2.vi.1954 (Steinhardt Museum collection) and Graves (1925) "have seen no 2 Gen. specimens from Palestine". No voucher specimen exists.

In Jordan: P. P. Graves did not find a second generation of the southern ssp. *dorae* ("the second generation is unknown") except "a dark rather worn male specimen taken at Wadi Sir on 14.viii.1923.". The voucher of this record has not been located. Larsen and Nakamura (1983) did not report a second brood except P.P. Graves' record.

In Lebanon: T. Larsen (1974: 123) reported "less common" August specimens in the mountains in "damp places". Peter Russell who bred genuine *Melitaea telona* from the Galilee (Golani junction) found that in his laboratory with fresh juicy *Centaurea* plants, Israelian *Melitaea telona* population may produce a second brood unknown in its natural biotope where it uses a different LHP (pers. comm. to DB). These rare second-brooded *M. telona* specimens provide additional proof that *M. telona* and *M. klili* originated from the common ancestor.

Legend

No.	Location	Type
1	Laqlouq, Lebanon,	B
2	Beirut, Lebanon	A
3	Mt. Hermon, Israel	B
4	Nahal Aviv, Israel	A
5	Nahal Shezor, Israel	A+B
6	Haifa, Israel	B
7	Nahal Tzipori, Israel	A+B
8	Herzeliya, Israel	A
9	Nahal Shilo, Israel	A+B
10	Ma'ale Efraim. Israel	A
11	Ein Sinya, Israel	A
12	Jerusalem, Israel	A+B
13	Wadi Zarga, Jordan	B
14	Arad, Israel	A
15	Ein Avdat, Israel	A
16	Wadi Nafha, Israel	B
17	Wadi Dana 545m, Jordan	B
18	Gebel Rum 1100m, Jordan	B

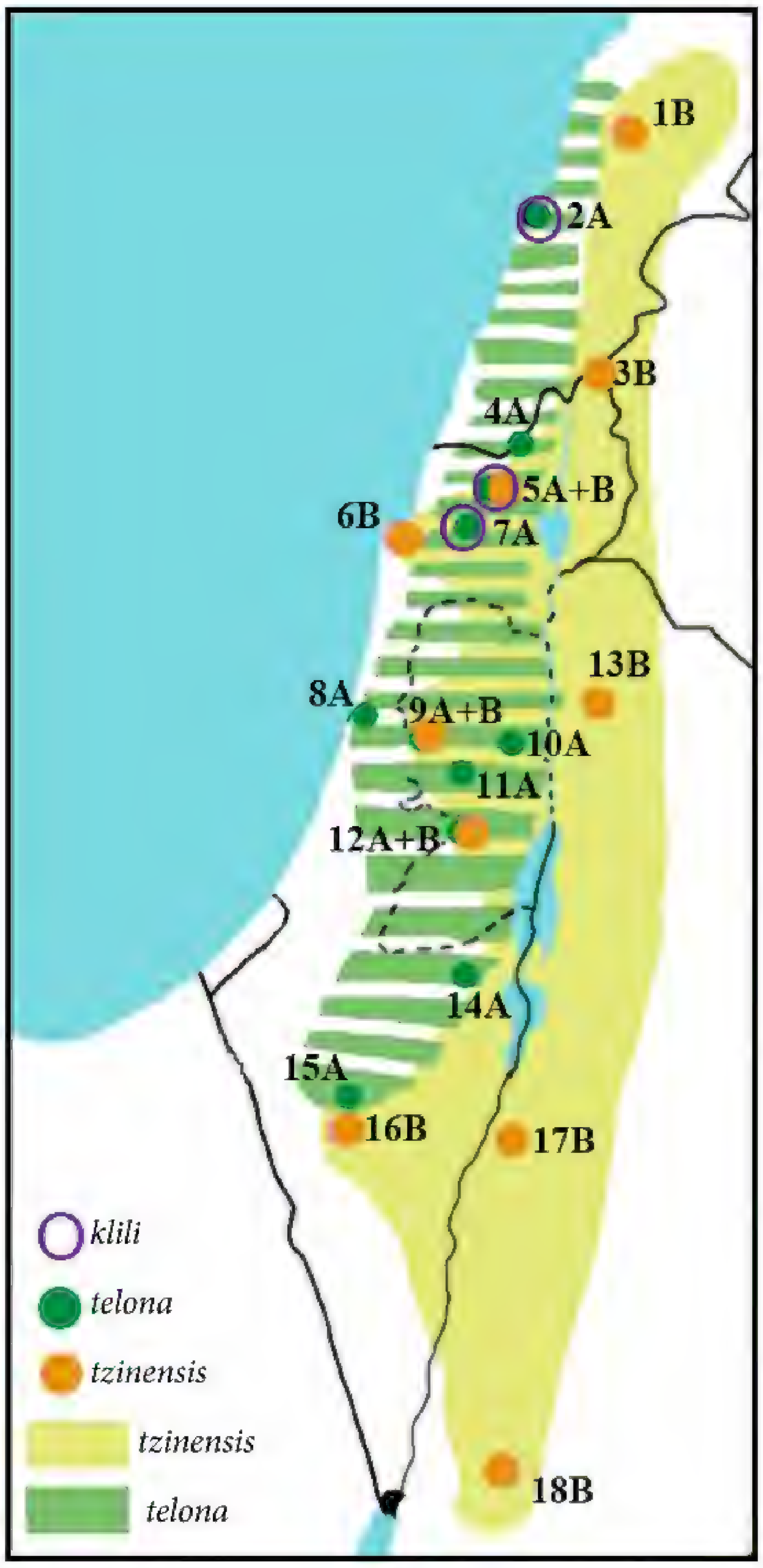


Fig. 3. Distribution of *Melitaea klili*, *M. telona* and *M. tzinensis*. VDP types A & B in southern Levant.

Melitaea tzinensis Benyamini, new species

The intensification of Levant's desertification shortened springs; shorter flowering period and earlier dehydration of the *Centaurea*'s main LHP stressed the single-brooded *M. telona* furthermore to produce smaller, *M. dorae*-size adults and to find additional alternative LHPs — e.g. at the Central Negev Mountains, the TL of the new species, these are *Centaurea eryngioides* Lam., *C. hyalolepis* Boiss., *C. pallescens* Delile on top of *C. iberica* Trevir. ex Spreng. In the Northern Negev at Nir Moshe grove they also lay eggs on *Crupina crupinastrum* (Moris) Vis. (Asteraceae). Further southwards in south Jordan's southern limit of *Melitaea telona* species group on top of Gebel Rum (29°34'46''N : 35°22'32''E, 1170 m), only 30 km short of Saudi-Arabian border, its LHP is the beautiful large-flowered *Centaurea eryngioides* Lam. that survives in rock cracks (Fig. 5). In these biotopes, *M. tzinensis* **n. sp.** with shorter VDP type B appeared. In fact, all the southern and eastern *M.* "*telonas*" are actually *M. tzinensis* and in the future when *M. klili* will disappear first, the *M. telona* will follow, and the *M. tzinensis* will expand northward with the deserts to become the dominant species.

Description of *Melitaea tzinensis* Benyamini, new species

LSID: urn:lsid:zoobank.org:pub:07391E98-B6EA-40BC-9428-2F24ACA28D44

Type material

Holotype, male, wingspan 20.30 mm. Labelled as: "W. Nafha (Handwritten) [/] ISRAEL (Printed) [/] 2.4.1976 (Handwritten) [/] D. Benyamini (Printed)".

Paratypes, three males (nos 01–03): 01 labelled as: "W. Dana (Handwritten) [/] 27.3.99 , 545 m (Handwritten) [/] JORDAN (Handwritten)". 02 labelled as: "W. Gebel Rum 1100m (Printed) [/] 8.4.2000 S. JORDAN (Printed) [/] Leg. Dubi Benyamini (Printed)". 03 labelled as: "HERMON 1630 m (Handwritten in Hebrew) [/] 21/7/22 (Handwritten) [/] Leg D.B (Handwritten)". All the type material will be deposited in the Steinhardt Museum of Natural History, Ramat Aviv, Tel Aviv, Israel.

Description

WL (n=4; holotype + paratype nos 1–3) 17.4–20.3 mm; average: 18.85 mm. Wing upperside ground colour near Pumpkin (see Maerz & Rea 1950: G10 PL 10), submarginal band colour between Marathon (see Maerz & Rea 1950: J12 PL11) and Punjab (see Maerz & Rea 1950: J12 PL 12) with pattern typical for the genus (Fig. 4).

Genitalia with VDP small type B with range of 0.575–0.690 mm (Figs 1, 2).

Diagnosis

It is a small single-brooded species of dry biotopes in Jordan, Negev Israel, west Syria on the eastern slopes of the Anti-Lebanon, and strays into dry biotopes in coastal south Levant (Fig. 3). Amongst the *M. telona* complex this new species has the smallest male genitalia valva with the VDP mean value 0.643 mm (n=16) of type B, compared with *M. telona* mean value 0.758 mm (n=43) of type A and *M. klili* mean value 0.788 mm of type A (Nahal Tzipori), and with mean value 0.676 mm of mixed types A and B (Nahal Shezor) (Figs 1a, b).

Etymology

The name comes from Nahal Tzin (Zin), *tzinensis* type locality — a large east-west Negev wadi, where the holotype was collected by the author.

Discussion

The present-day Levant distributional map (Fig. 3) clearly highlights this ecological process with the dominant *M. telona* in the middle (green strips and spots), disappearing *M. klili* enclaves in western Galilee and Beirut (blue circles) and the southern new species *M. tzinensis* that will eventually expand northwards from its origin in the southern and eastern deserts of south Jordan and central Negev in south Israel to become the dominant single-brooded species with small VDP and the habitus with orange spots over yellow background.

General analysis of VDP

Two groups are defined on the basis of genitalia traits: (1) type A = the large VDP with 0.700 to 0.887 mm long which correlates to *Melitaea klili* and *Melitaea telona* and (2) type B = the short VDP with 0.575 to 0.693 mm long which correlates to *Melitaea tzinensis* **n. sp.** (Figs. 1a, 2).

VDP comparison of *M. klili* from localities in western Galilee presents the proof that the ecological process is evident. We compared the Nahal Tzipori wet biotope with a permanent flowing rivulet and its nearly dominant *M. klili* population with up to three annual broods, and type A VDP (average 0.788 mm, n=18) with the Nahal Shezor desiccated biotope that is actually a typical wadi (dry valley bed) with only remnants of the wet biotope it used to be. Here we find the widest VDPs range from the archaic type A VDP it used to be to the newcomer "invading" type B = my new species that will evidently become the dominant and only species present of the *M. telona* complex (average 0.676 mm, n=21) (Fig. 1b). This newcomer will have to cope with the expanding deserts, in the Anthropocene era, and will possibly have to change its LHP or add desert LHPs in order to survive. Like Pieridae spp. with long term pupal diapause (Benyamini 2008), probably future generations of lepidopterists may discover that similar long-term diapause will/might also appear in the *Melitaea* spp.

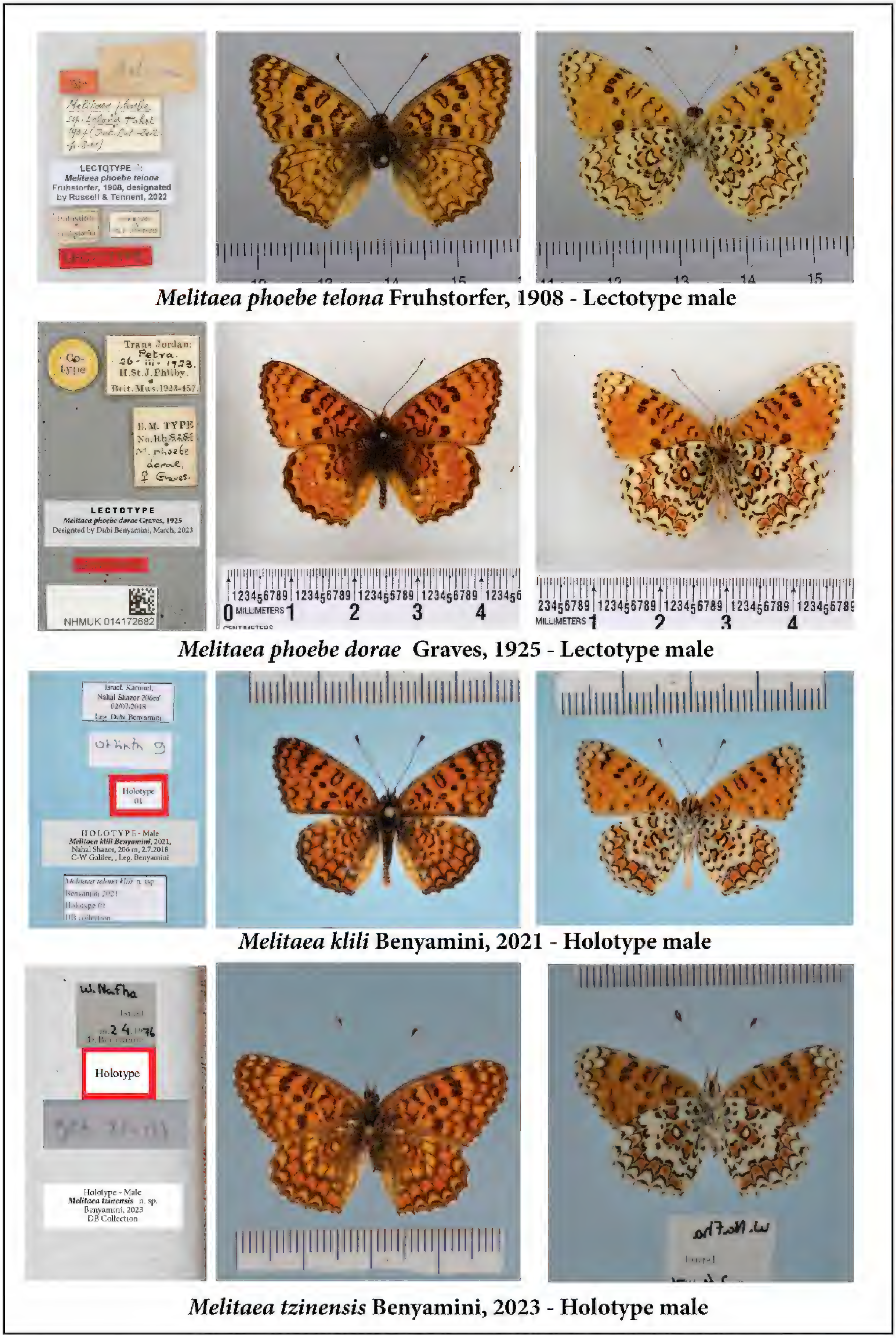


Fig. 4. Lectotypes of *Melitaea telona* and *M. dorae*. Holotypes of *M. klili* and *M. tzinensis* **n. sp.**

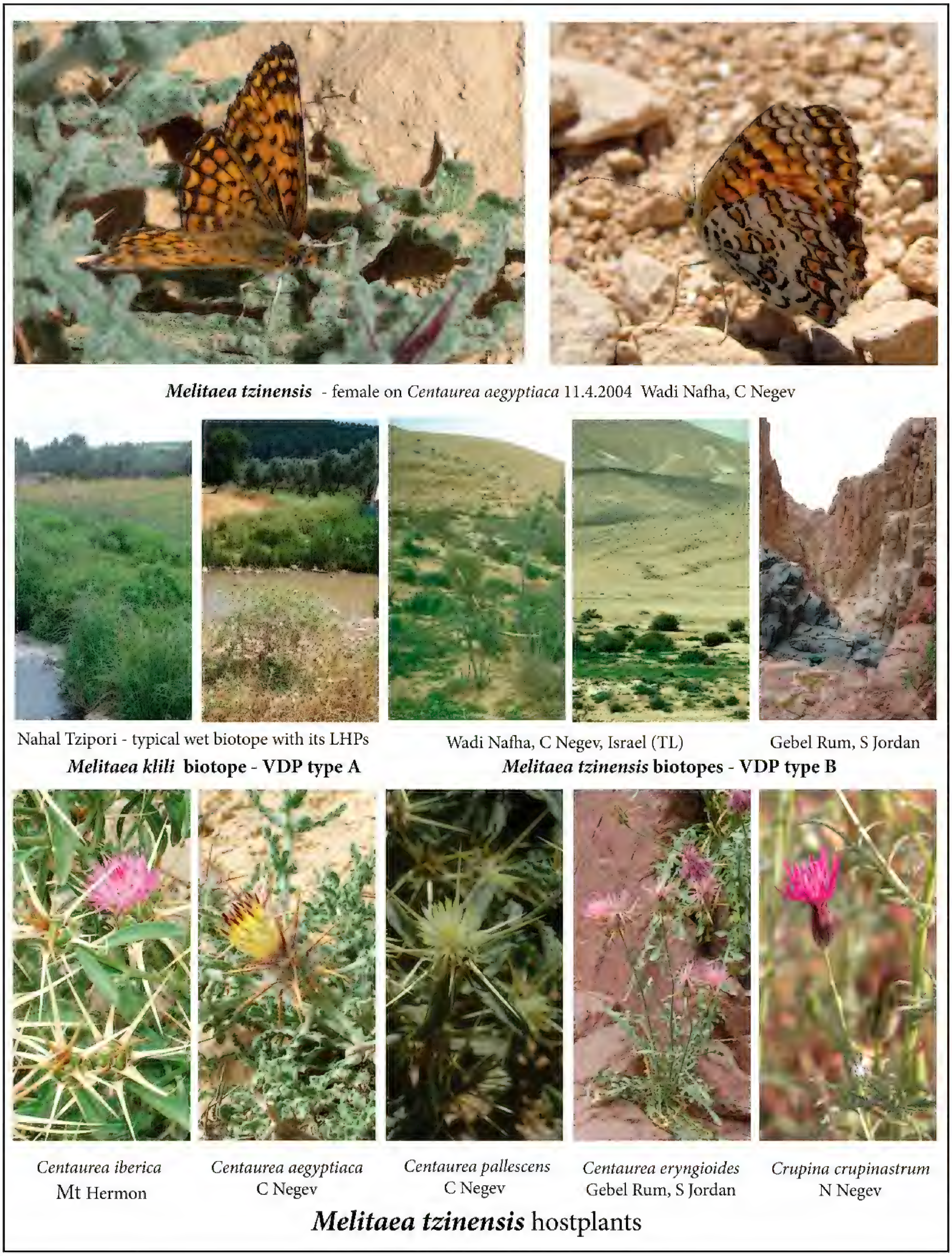


Fig. 5. *Melitaea tzinensis* **n. sp.** Type locality: Wadi Nafha; female in TL and on LHP.
M. klili wet biotope at Nahal (Rivulet) Tzipori with *Centaurea iberica* as LHP, Galilee, Israel.

Comparison of VDP in material collected in Jerusalem 1907–2022

We compared the material collected in Jerusalem from 1907 until 2022 and based our comparisons on type specimens deposited in DB & Steinhardt N.H. collections. We tried to check the long-term change of VDPs of 22 collected males collected in Jerusalem and neighbouring plateaux localities between 1907 (lectotype and two paralectotypes) and 2022 (Nahal Shilo). We received a very moderate average VDP decline from 0.752 mm to 0.721 mm over the 105 years. This slight but clear decline expresses the trend of desertification process in the east Mediterranean and the ongoing process of change of populations from *M. klili* (wide type A) through *M. telona* (types A and B) to *M. tzinensis* (small type B) (Fig. 1c).

DNA sequencing results

DNA sequencing of *M. telona, M. klili, M. tzinensis* **n. sp.** done for us in Barcelona (CSIC-UPF labs, Vila pers. comm. to DB) showed only tiny negligible changes between the species of *M. telona* complex. It seems that this molecular clock is not the sensitive tool that we need for such a quick and accelerating speciation process that we face in our Anthropocene period, and thus it cannot sense this change. In fact, the evolutional epigenetic cell memory left us a few clues to understanding the dramatic species-changeover from archaic *M. klili* through present day *M. telona* to the final and dominant survivor *M. tzinensis* **n. sp.** in the future.

Acknowledgements

John G. Coutsis of Athens, the leading and most experienced Greek lepidopterist, is cordially thanked. His drawings of male genitalia of all the *M. telona* species complex enabled the author to make the breakthrough of understanding the evolutionary history of this complex — thank you, John, for your precise and perfect drawings.

DB's devoted assistant Mr Ofir Tomer, the new butterfly collection manager at the Steinhardt Natural History Museum, Tel Aviv is DB's helper in the field. In this article he prepared the VDP figures based on the drawings of John Coutsis. Dr Zsolt Bálint, the leading curator of butterflies in the Hungarian Natural History Museum read the draft of this article; his remarks were accepted willingly. Dr Orr Comay (HaMaarag, Israel) assisted with Levant's Paleoclimate, sent relevant publications to DB and commented on the draft of this article. Peter Russell bred (in the UK) L3 larvae from *M. klili* biotopes in the Western Galilee, Israel, supplied by DB; this mutual experiment is still unfinished. Roger Vila and Cecilia Corbella Felip (CSIC — UPF) Barcelona, Spain carried out the DNA sequencing of our *M. telona* complex specimens. Thanks to the anonymous English editor for his fine editing. The gifted Leah Benyamini prepared the colour plates and made the final touch-up of the manuscript.

To all these people, the author extends his sincere thanks.

References

Benyamini D. 2008. Is *Euchloe falloui* Allard, 1867 (Pieridae) the butterfly with the longest diapause? — *Nota Lepidopterologica* **31**(2): 293–295. https://www.biodiversitylibrary.org/page/9648659

Benyamini D. 2021. *Butterflies of the Levant Vol III Nymphalidae*. — 4 D MicroRobotics Ltd. Israel, 240 pp.

Frumkin A. & Comay O. 2021. The last glacial cycle of the southern Levant: Paleoenvironment and chronology of modern humans. — *Journal of Human Evolution* **160**: 1–8.

Goldreich Y. 1998. *The Climate of Israel – Observations, Research and Applications*. — Khidekel publishing house, Tel-Aviv. 292 pp.

Graves P. P. 1925. The Rhopalocera and Grypocera of Palestine and Transjordania. — *Transactions of the Royal Entomological Society of London* **73**(1–2): 17–125.

Larsen T. B. 1974. *Butterflies of Lebanon*. — National Council for Scientific Research, Beirut, 256 pp.

Ludwig P. & Hochman A. 2021. Last glacial maximum hydro-climate and cyclone characteristics in the Levant: a regional modelling perspective. — *Environmental Research Letters* **17**: 014053: (1–15). https://doi.org/10.1088/1748-9326/ac46ea

Maerz A. & Rea P. M. 1950. *A Dictionary of Color*. — McGraw-Hill Book Company, Inc., 208 pp.

Torfstein A. & Enzel Y. 2017. Dead Sea Lake level change and Levant Palaeoclimate. — *In*: Enzel Y. & Bar-Yosef O. *Quaternary of the Levant : Environments, Climate Change, and Humans*. — Cambridge University Press, pp. 115–125.

A morphological study of *Leptidea* (Lepidoptera: Pieridae) species from south-western Bulgaria

Karel Konečný

Abstract. The author presents the morphological observations of three males and two females of a species from the genus *Leptidea* (Pieridae).

Samenvatting. De auteur presenteert de morfologische vergelijking van drie mannetjes en twee vrouwtjes van een soort uit het genus *Leptidea* (Pieridae).

Résumé. L'auteur présente la comparaison morphologique de trois mâles et deux femelles d'une espèce du genre *Leptidea* (Pieridae).

Key words: Bulgaria — *Leptidea* — Morphology.

Konečný K.: Bechyňská 1231/8, 39001 Tábor, Czech Republic. iphigenia@centrum.cz

DOI: 10.6084/m9.figshare.22722910

Introduction

I have been observing for seven years the Lepidoptera species in southwestern Bulgaria. My special attention was focused on the genus *Leptidea* (Pieridae) because of the observed morphological variability of butterflies depending on the location of capture (Jakšič 1998; Slamka 2004; Tolman & Lewington 2008; Kudrna *et al*. 2015). In this short note, I intend to make clear that in the genus *Leptidea* a small morphological variability is observed in genitalia depending upon the location of capture of the specimens.

Material and methods

Approximately sixty specimens of the genus *Leptidea* were studied in detail during my seven years of research. The location of capture was carefully noted while photographing a specimen, also the date of capture, and GPS coordinates. The selected specimens from different localities were dissected and the ratio of uncus/valva was measured in detail.

Results

The results are presented in the illustrations (Figs 1–6).

Discussion and conclusion

I noticed a slight morphological variability in the *Leptidea* specimens that I have examined. The use of the ratio uncus length/valval length might be a useful character in the studies of the *Leptidea* species. My observations are in line with the conclusions presented in the article by Dapporto *et al*. (2022).

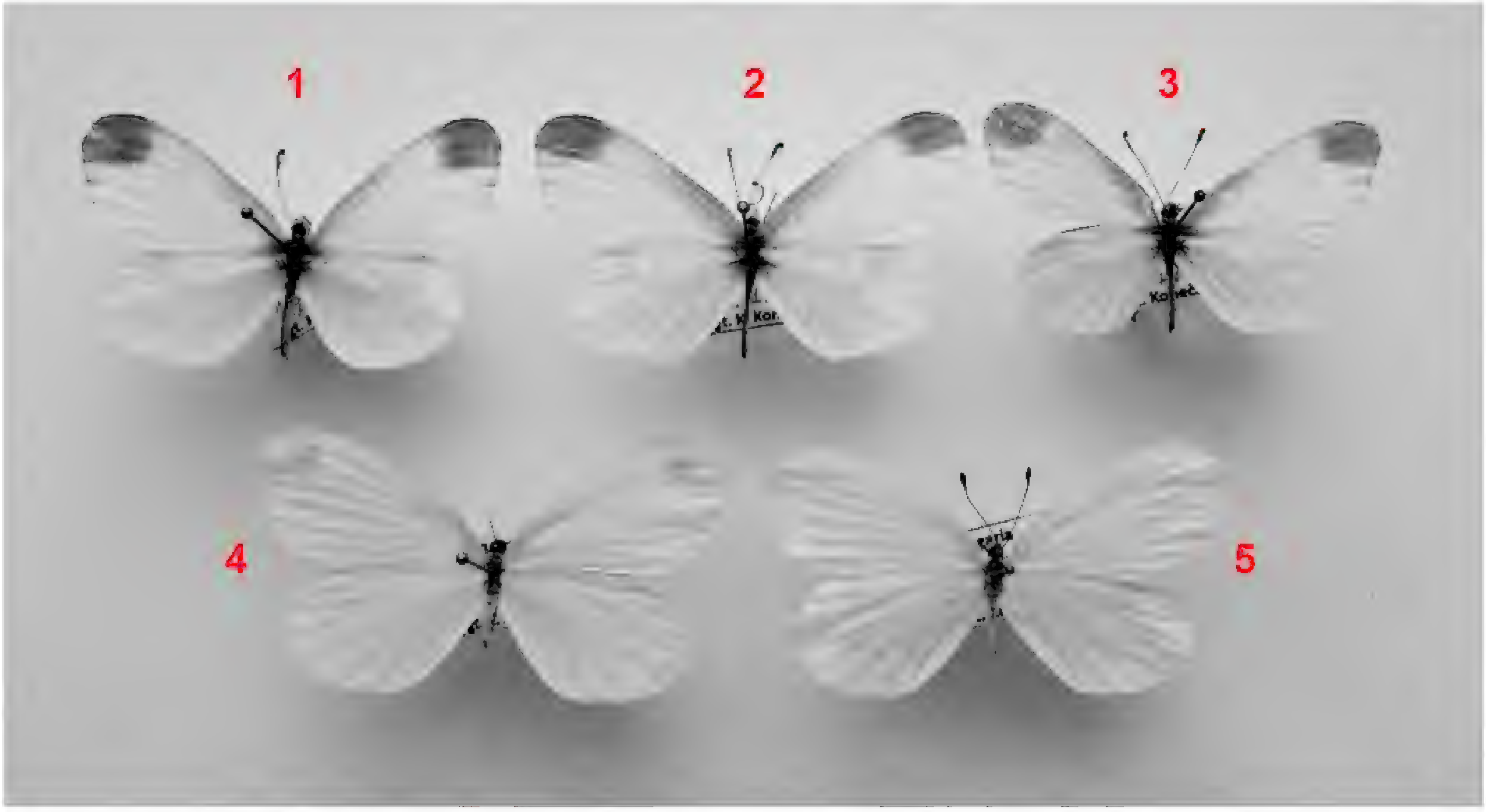


Fig. 1. The upper side of the *Leptidea* species collected in Bulgaria.

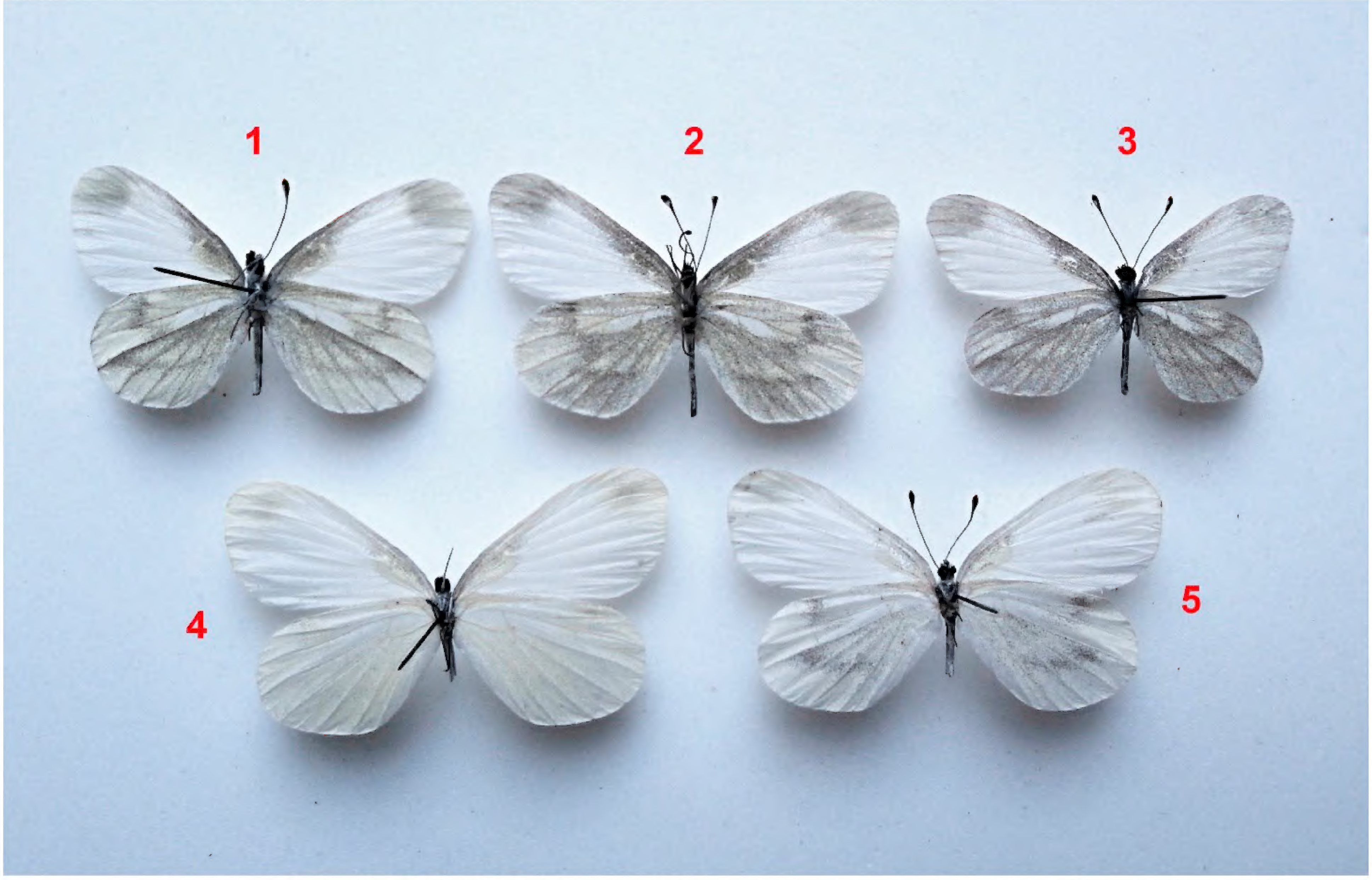


Fig. 2. The underside of the *Leptidea* species collected in Bulgaria.

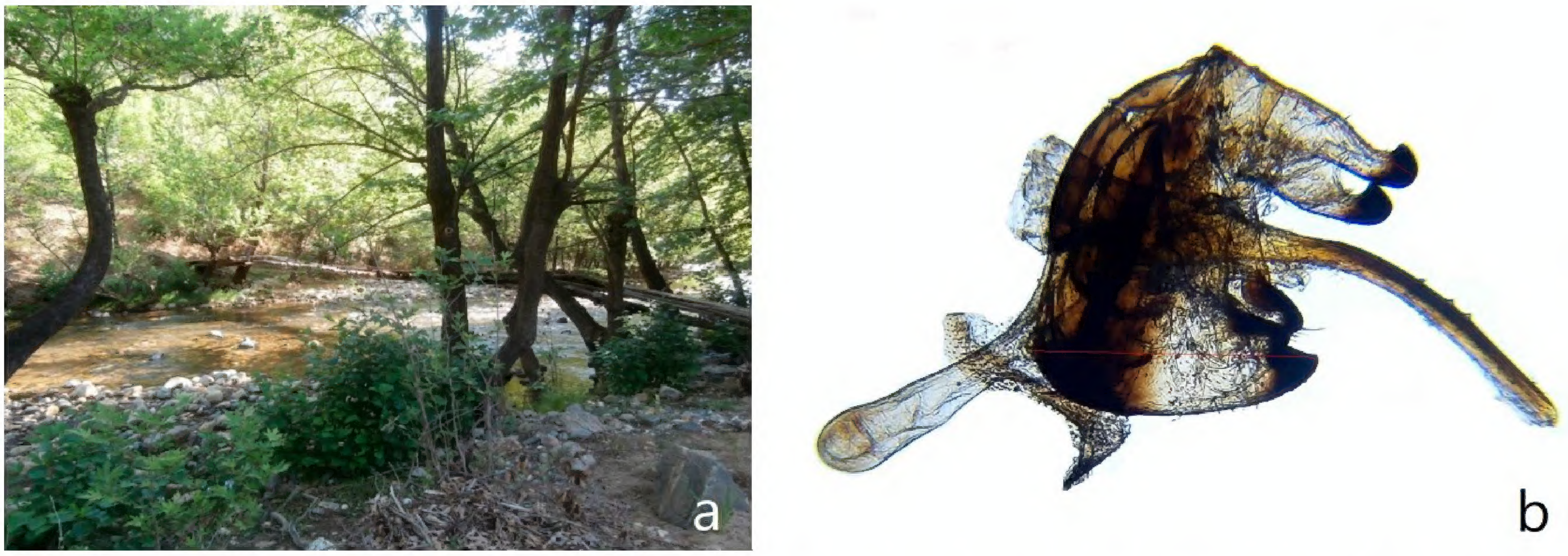


Fig. 3. Specimen 1 ♂, a, valley of river Lebnice, Bulgaria, 14.v.2017; b, male genitalia ratio uncus length/valval length 69,22 µm/80,98 µm=0,855.

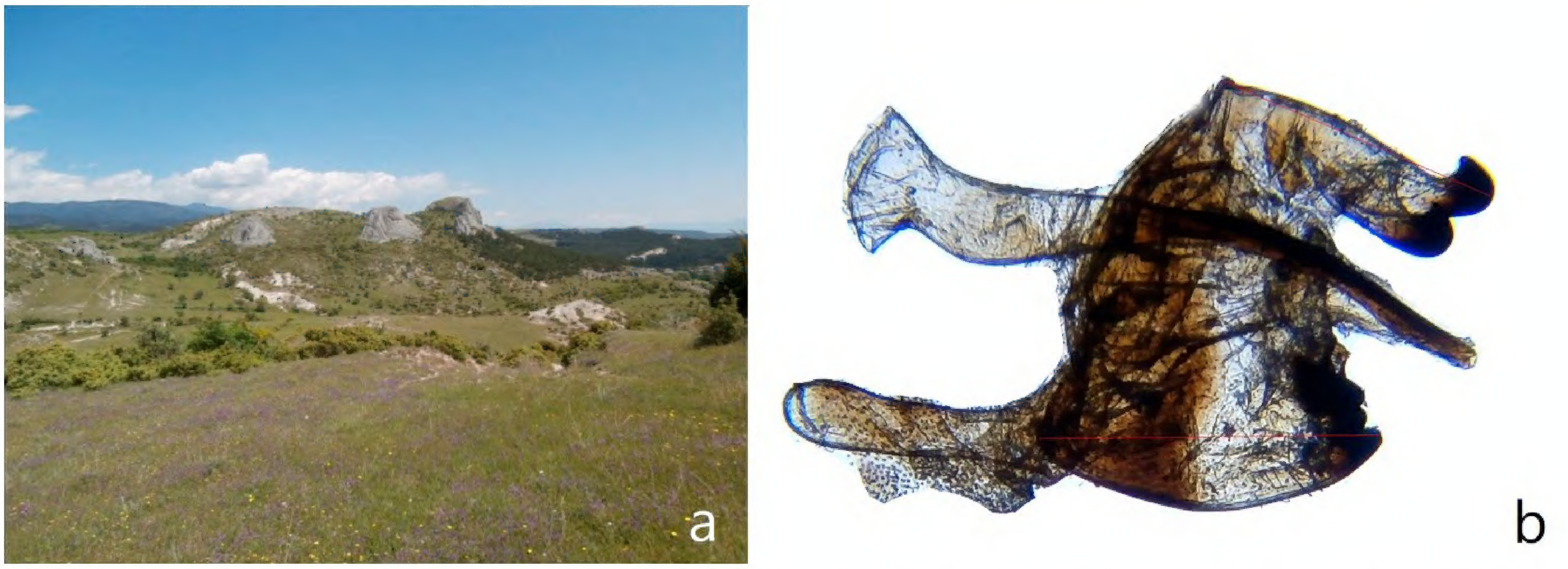


Fig. 4. Specimen 2 ♂, a, north-east of Ilindentsi, alt. 550 mm, Bulgaria, 08.vi.2015; b, male genitalia ratio uncus length/valval length 71,30 µm/82,06 µm=0,868.

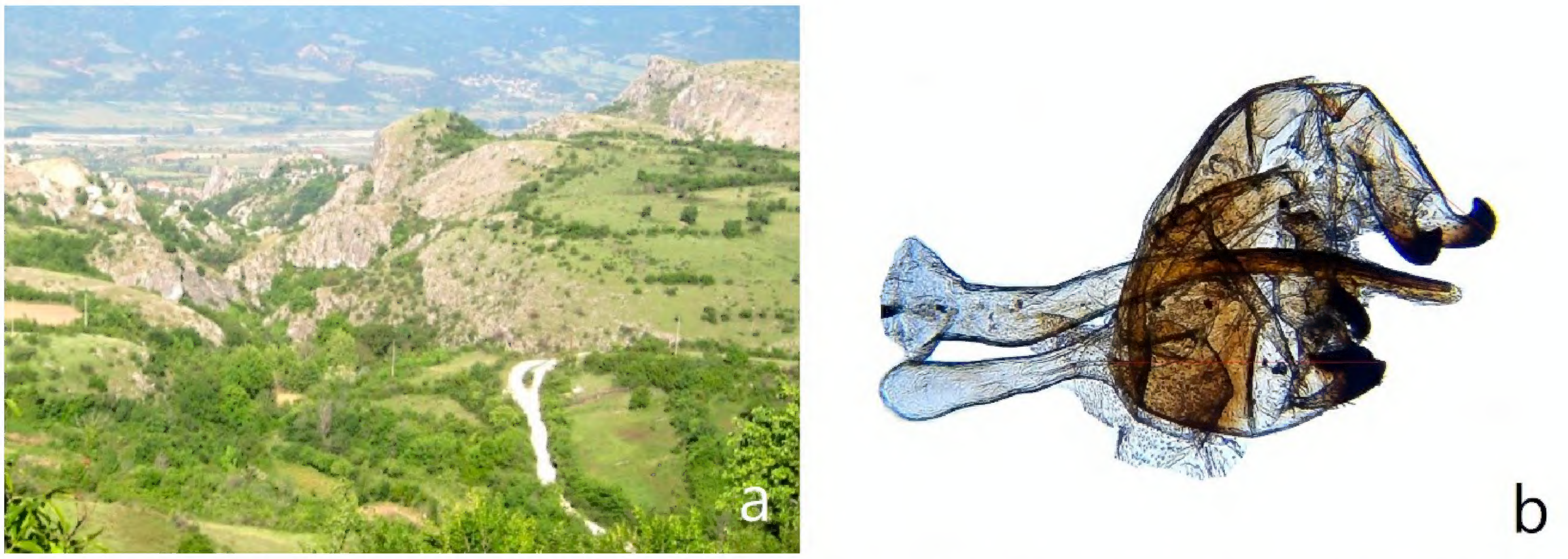


Fig. 5. Specimen 3 ♂, a, south-west of Ploski, alt. 550 mm, Bulgaria, 18.v.2017; b, male genitalia ratio uncus length/valval length 64,89 µm/75,75 µm=0,856.

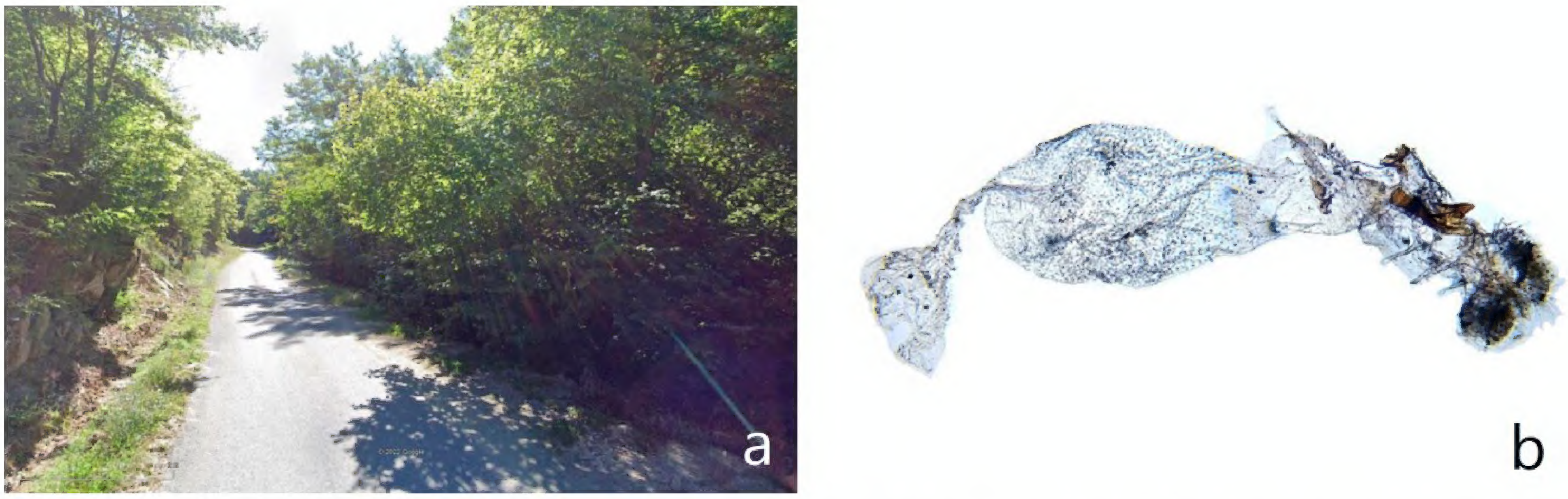


Fig. 6. Specimens 4, 5 ♀♀, a, Petrovo, 3km směr Izvora, Bulgaria, 21.vi.2018, 28.vi.2019; b, female genitalia of the specimen collected on 21.vi.2018.

Literature

Dapporto L., Menchetti M., Raluca Vodă R., Corbella C., Cuvelier S., Djemadi I., Gascoigne-Pees M., Hinojosa J. C., Lam N. T., Serracanta M., Talavera G., Dincă V. & Vila R. 2022. The atlas of mitochondrial genetic diversity for Western Palaearctic butterflies — *Global Ecology and Biogeography* **31**: 2184–2190. https://onlinelibrary.wiley.com/doi/10.1111/geb.13579

Jakšič N. P. 1998. *Male genitalia of butterflies on Balkan Peninsula with a checklist (Lepidoptera: Hesperioidea and Papilionoidea)*. — František Slamka, 144 pp.

Kudrna O., Pennerstorfer J. & Lux K. 2015. *Distribution of European butterflies and skippers*. — Wissenschaftlicher Verlag, Schwanfeld, 632 pp.

Slamka F. 2004. *Die Tagfalter Mitteleuropas. Östlicher Teil: Bestimmung, Biotope und Bionomie, Verbreitung, Gefährdung*. — František Slamka, 288 pp.

Tolman T. & Lewington R. 2008. *Collins Butterfly Guide. The Most Complete Guide to the Butterflies of Britain and Europe*. — HarperCollins Publishers, London, 384 pp.

Supplement file

Video: Butterfly research in south-western Bulgaria **27 min**
https://vimeo.com/803864502

Boekbesprekingen

DOI: 10.6084/m9.figshare.22722913

Basquin P. & Faravel G. 2022. *Les Saturnidés du Gabon*. Catalogue illustré des Saturniidae du Gabon. Tome 2: Buneini, Attacini. 21 × 30 cm, 120 p., te bestellen bij Patrick Basquin, basquin.p@wanadoo.fr, paperback, 35,- EUR + 5,- EUR portkosten, (ISSN 978-2-9569898-3-7).

In dit tweede deel van de geïllustreerde catalogus van de Saturniidae van Gabon worden alle soorten opgenomen uit de Buneini en Attacini. Het gaat om 47 verschillende soorten waarvan de meeste een groter formaat hebben dan de soorten uit het eerste deel. Dat maakt dat er slechts twee foto's van adulten op één pagina kunnen en daarmee is het boek dus iets dikker uitgevallen, ook al is het aantal behandelde soorten iets kleiner dan in het eerste deel (60 soorten).

Net als met het eerste deel, dat in 2021 werd gepubliceerd, heeft ook dit boek een dubbel doel. Ten eerste willen de auteurs een gids voorstellen voor alle entomologen die in de Afrotropische nachtvlinders geïnteresseerd zijn, en ten tweede willen ze aan de Gabonese bevolking de rijkdom tonen van een deeltje van de veelzijdige natuur van hun land.

Nog meer dan in het eerste deel over de Gabonese Saturniidae is in dit boek de tekst erg kort gehouden. Naast de volledige wetenschappelijke naam van elke soort, met verwijzing naar de plaats van de originele beschrijving, wordt heel summier de type-lokaliteit vermeld en in welk museum het holotype zich bevindt. De algemene verspreiding wordt aangegeven en in meer detail de verspreiding in Gabon. De voorkeurhabitat wordt kort beschreven. Slechts in enkele gevallen wordt info gegeven over de voedselplanten van de rups.

Na een korte situering van beide groepen in de subfamilie Saturniinae, het tribus Buneini met 43 soorten ingedeeld in 11 genera en het tribus Attacini met slechts 4 soorten ondergebracht in het enige genus *Epiphora*, volgt een duidelijke kaart van Gabon. Hierop kan men aflezen waar de 13 nationale parken van Gabon zich bevinden en vindt men ook de meest belangrijke vindplaatsen die in de tekst en de onderschriften bij de foto's worden vermeld. Door het gebruik van verschillende kleuren kan men zich een idee vormen van de hoogteverschillen in Gabon. Daarna volgt een voorwoord door Rodolphe Rougerie die het boek aanprijst, vooral voor de jeugdige studenten uit Gabon.

Op een kleurenplaat wordt de familie Saturniidae vergeleken met de overige 9 families van de superfamilie Bombycoidea en met de Lasiocampidae. In een kort voorwoord wordt verder verwezen naar de inleidende hoofdstukken in het eerste deel waar info werd gegeven over de classificatie, de morfologie van de verscheidene stadia en een voorstelling van de verschillende biotopen in Gabon. Deze info wordt hier niet herhaald om plaats te sparen voor enkele extra foto's.

Deze foto's zijn van uitstekende kwaliteit en worden op 98 platen bijeengebracht. De vlinders worden op ware grootte afgebeeld en omdat het bijna altijd om grote exemplaren gaat, kunnen er slechts twee foto's per plaat, telkens de boven- en onderkant van hetzelfde exemplaar. Onderaan wordt de lokaliteit en vangdatum vermeld. Indien mogelijk wordt voor elke soort een mannetje en een vrouwtje afgebeeld, wat dus resulteert in 4 foto's per soort. Hiervan wordt slechts in uitzonderlijke gevallen afgeweken, b.v. bij de mannetjes van *Pseudobunaea cleopatra* of *Cirina forda* die klein genoeg zijn zodat de 4 foto's van 2 verschillende mannetjes op 1 plaat kunnen. Anderzijds moet b.v. *Lobobunaea basquini* het met 1 plaat stellen omdat het vrouwtje van deze soort nog onbekend is.

Achter deze reeks kleurenplaten volgt een vergelijking met de Saturniidae-fauna uit de buurlanden van Gabon: Kameroen, Congo, Equatoriaal Guinea (met vooral het eiland Bioko) en de archipel São Tomé en Príncipe. Daaruit blijkt enerzijds dat sommige soorten eventueel nog te ontdekken vallen in Gabon, en anderzijds dat een hele reeks soorten die uit deze landen bekend zijn, onmogelijk in Gabon kunnen aangetroffen worden, gewoon omdat de juiste biotopen er ontbreken. Dit hoofdstuk is eveneens zeer rijkelijk geïllustreerd met kaarten en foto's van biotopen, maar vooral van vlinders, waaronder vele type-exemplaren.

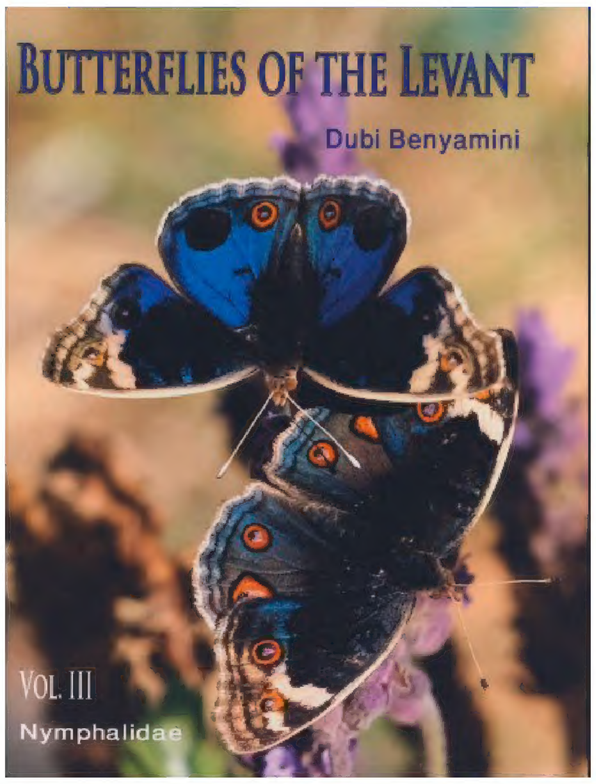
Een uitgebreide literatuurlijst sluit dit boek af. Het is, net als het eerste deel, zeer verzorgd uitgegeven en rijkelijk geïllustreerd. Wie het eerste deel reeds bezit zal dit tweede niet kunnen missen en al wie geïnteresseerd is in de Afrikaanse vlinderfauna in het algemeen en in de rijke fauna van Gabon in het bijzonder, zal niet teleurgesteld worden door beide delen.

Willy De Prins

DOI: 10.6084/m9.figshare.22722919

Benyamini D. 2021. Butterflies of the Levant and nearby areas. Vol. III Nymphalidae: Libytheinae, Danainae, Charaxinae, Satyrinae, Limenetidinae, Biblidinae, Heliconiinae, Nymphalinae.

21,5 × 30 cm, 240 p., 1466 afbeeldingen in kleur, te bestellen bij een gespecialiseerde boekhandel, o.a. Pemberley Books, https://www.pemberleybooks.com/ (£120,-), prijs onder voorbehoud en zonder verzendkosten (ISBN 978-965-92822-1-0).



Dit is het derde deel in een geplande reeks van vier boeken over de vlinders van de Levant. Zoals in de boekbespreking van het tweede deel uit deze reeks (*Phegea* 49(3): 143) reeds aangehaald, wordt met de Levant een niet exact omschreven gebied aangeduid dat vooral de landen Israël, Jordanië, Libanon en Syrië omvat. Daarnaast worden ook de vlinders besproken die in de aangrenzende gebieden voorkomen: Cyprus, Noordoost-Egypte (vooral de Sinaï), West-Irak, Noordwest-Saoedi-Arabië (Hejaz) en Zuid-Turkije (Hatay). In het totaal gaat het om 96 soorten die in dit geopolitiek moeilijk toegankelijke gebied voorkomen.

Uit de titel van het boek blijkt al meteen dat het om een zeer heterogene groep gaat. Veel van de besproken onderfamilies werden trouwens vroeger als aparte families aangezien. Van de Libytheinae komt in de Levant slechts één soort voor: de bekende *Libythea celtis*. De Danainae omvatten de wijd verspreide en zeer variabele *Danaus chrysippus* en de eerder zeldzame *Danaus plexippus* die enkel op Cyprus vaste populaties heeft maar af en toe in de Levant zelf opduikt als migrerende exemplaren. De Charaxinae worden eveneens door twee soorten vertegenwoordigd: de algemene *Charaxes jasius* en de Afrikaanse *C. hansali* die af en toe in Zuid-Egypte en in Saoedi-Arabië wordt waargenomen. Deze laatste soort is dus nog nooit in de Levant zelf aangetroffen.

De Satyrinae tellen 39 soorten in de Levant. Naast de soorten die in verbinding staan met populaties uit Turkije, zoals o.a. in de genera *Kirinia, Lasiommata, Hyponephele, Chazara, Hipparchia, Pseudochazara, Satyrus* en *Ypthima*, komen er ook enkele namen voor die de West-Europese lepidopteroloog maar zelden tegenkomt: b.v. *Melanitis leda* (enkel in de meest zuidoostelijke delen van het besproken gebied), *Hipparchia tewfiki* (uitsluitend in het noordoosten van Saoedi-Arabië), of *Satyrus makmal* (endemisch in de Levant). Een bijzonder geval is *Proterebia phegea* waarvan verondersteld wordt dat er vroeger een populatie moet hebben voorgekomen in het zuiden van Libanon.

De Heliconiinae zijn met 8 soorten uit de genera *Clossiana, Issoria, Brenthis* en *Argynnis* vertegenwoordigd. De Limenitidinae tellen slechts 1 soort, *Limenitis reducta*, die vooral langs de hele kustlijn voorkomt. De subfamilie Biblidinae heeft geen vertegenwoordigers in Europa, maar vanuit Hejaz dringen vertegenwoordigers van de xerotherme soorten *Byblia ilithya* en *B. anvatara* hoogst zeldzaam tot in de zuidelijke delen van de Levant door. De Nymphalinae bevatten naast de o.a. ons wel bekende *Vanessa cardui, V. atalanta* en *Aglais urticae*, enkele andere soorten waarvan de namen ons veel minder vertrouwd in de oren klinken, zoals *Junonia orithya* (zie foto van de voorpagina). Een belangrijk deel van deze subfamilie wordt echter ingenomen door het tribus Melitaeini, met het enige genus *Melitaea* dat behandeld wordt op niet minder dan 37 pagina's. Naast de te verwachten *Melitaea cinxia, M. phoebe, M. telona, M. collina, M. arduinna, M. didyma, M. syriaca, M. deserticola* en *M. athalia*, wordt ook de in Europa onbekende *Melitaea acentria* opgenomen en verder worden er twee nieuwe *Melitaea*-soorten beschreven: *M. klili* en *M. israela*. Hierbij worden vele genitaaltekeningen door J. Coutsis afgebeeld, jammer genoeg in een iets te klein formaat zodat niet altijd de nodige details kunnen worden waargenomen.

Zoals in het vorige deel wordt de bespreking van de soorten voorafgegaan door een overzicht van de vlinderfamilie met algemene informatie over de voedselplanten, de eerste stadia en enkele bijzonderheden zoals diapause, thermoregulatie, hilltopping, migratie, bescherming. enz. Dan volgt een systematische lijst van de soorten die in de Levant voorkomen. Deze lijst is geïllustreerd met een foto van een adult in de vrije natuur, een ei, rups en pop. Bij de behandeling van de afzonderlijke soorten staat de tekst op de linker bladzijde terwijl de foto's rechts staan afgedrukt. Voor sommige soorten volstaat één pagina niet en dan wordt de informatie over verscheidene pagina's verspreid. Bij andere is er minder informatie beschikbaar en dan staan zowel de tekst als de foto's op dezelfde pagina. Telkens wordt uitgebreide informatie gegeven over de biologie: vliegtijd, aantal generaties, gedrag van de rupsen, verpopping, predatoren en parasitoïden, migratie, voedselplanten van de rups en gedrag van de adulten. Verder is er informatie over de verspreiding van de soort met daarbij aandacht voor de ondersoorten. Bij elke soort hoort een verspreidingskaartje van het voorkomen in het behandelde gebied. Soms is die verspreiding in twee kleuren aangeduid: rood waar de soort standvastig is en roze waar ze slechts sporadisch wordt aangetroffen door migratie, zwerfgedrag, enz. Met symbolen worden de belangrijkste kenmerken aangeduid. In een overzichtelijk histogram wordt aangetoond in welke maanden van het jaar men de eieren, rupsen, poppen en vlinders kan aantreffen.

Het boek is zeer rijkelijk geïllustreerd. Bijna alle rechter pagina's zijn gevuld met foto's van opgezette museumexemplaren, vlinders die nectar zuigen op bloemen en ook met veel foto's van pre-imaginale stadia, iets wat men in vele andere vlinderboeken zelden tegenkomt. De meeste foto's zijn het werk van de auteur maar meer dan 50 fotografen hebben meegewerkt om dit boek zo rijkelijk mogelijk te illustreren.

Na dit derde boek in de reeks, komt er nog een deel dat de Lycaenidae zal behandelen en een boek over de biologie van de dagvlinders in de Levant. De auteur en zijn collega's hebben nl. een zeer uitgebreid kweekprogramma uitgevoerd dat talrijke nieuwe informatie verschaft over de levenswijze en biologie van de dagvlinders. Het boek sluit af met een glossary, een systematische lijst van de behandelde soorten en een uitgebreide literatuurlijst. Het is zeer keurig uitgegeven.

Willy De Prins

 ISSN 0771-5277